From:	Farquharson, Chenise
To:	Miller, Sofie E. EOP/OMB
Cc:	Kee, Annie; Wisniewski, Christian (he/him/his); Pordesimo, Kristine
Subject:	RE: 2060-AV84 - Phasedown of Hydrofluorocarbons: Management of Certain Hydrofluorocarbons and Substitutes (Final Rule)
Date:	Monday, May 13, 2024 9:48:20 AM

Good morning Sofie,

I hope you also had a nice weekend! That's great and you're correct--it would be the interagency briefing. We're looking forward to providing an update next Tuesday.

Thanks,
Chenise

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Chenise Farquharson
Supervisor, Emissions Reduction Branch
Stratospheric Protection Division
Office of Atmospheric Protection
U.S. Environmental Protection Agency
[redacted]

From: Miller, Sofie E. EOP/OMB [redacted]
Sent: Monday, May 13, 2024 9:39 AM
To: Farquharson, Chenise [redacted]
Cc: Kee, Annie [redacted]; Wisniewski, Christian (he/him/his) [redacted]; Pordesimo, Kristine [redacted]
Subject: RE: 2060-AV84 - Phasedown of Hydrofluorocarbons: Management of Certain Hydrofluorocarbons and Substitutes (Final Rule)

> **Caution:** This email originated from outside EPA, please exercise additional caution when deciding whether to open attachments or click on provided links.

Hi Chenise,

Hope you had a nice weekend, and thanks for offering the below times for a briefing (I assume interagency briefing vs. OMB-only, now that the rule is submitted). Tuesday 5/21 at 10am works for us, I'll send you an invite shortly.

Best,

Sofie

From: Farquharson, Chenise [redacted]
Sent: Thursday, May 9, 2024 1:34 PM
To: Miller, Sofie E. EOP/OMB [redacted]

Cc: Kee, Annie [redacted]; Wisniewski, Christian (he/him/his) [redacted]; Pordesimo, Kristine [redacted]
Subject: 2060-AV84 - Phasedown of Hydrofluorocarbons: Management of Certain Hydrofluorocarbons and Substitutes (Final Rule)

Hi Sofie,

EPA transmitted on May 7th the "Phasedown of Hydrofluorocarbons: Management of Certain Hydrofluorocarbons and Substitutes under Subsection (h) of the American Innovation and Manufacturing Act of 2020 (Final Rule)" (2060-AV84) to OMB. I understand there is agreement on a 90-day review.

As Luke mentioned previously, the complete package contains 11 documents in total:

- Final rule preamble (including the response to comments) and regulatory text
- Regulatory impact analysis (RIA) Addendum
- RIA TSD
- Economic table
- ICR supporting document
- Reclamation report
- Automatic leak detection TSD
- Cylinders TSD
- Confidentiality determination memo
- Response to comments document regarding amendments to RCRA standard
- SC-GHG supplementary data tables

Annie, Christian, and I will be the rule POCs and I've copied in Kristine from OP. Please let us know if you'd like to schedule an overview briefing next week or the week of the 20th. We're available the following days and times:

- Wednesday (5/15): 10am
- Tuesday (5/21): 10 am, 1pm
- Wednesday (5/22): 1pm

Thanks in advance and we're looking forward to working with you to move this rule through interagency review.

Chenise

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Chenise Farquharson
Supervisor, Emissions Reduction Branch
Stratospheric Protection Division
Office of Atmospheric Protection
U.S. Environmental Protection Agency
[redacted]

6560-50-P

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 84, 261, 262, 266, 270, and 271

[EPA-HQ-OAR-2022-0606; FRL-10105-01-OAR]

Phasedown of Hydrofluorocarbons: Management of Certain Hydrofluorocarbons and Substitutes under Subsection (h) of the American Innovation and Manufacturing Act of 2020

AGENCY: Environmental Protection Agency (EPA)

ACTION: Final rule.

SUMMARY: The U.S. Environmental Protection Agency is issuing regulations to implement certain provisions of the American Innovation and Manufacturing Act of 2020. This rulemaking establishes an emissions reduction and reclamation program for the management of hydrofluorocarbons that includes requirements for leak repair and installation and use of automatic leak detection systems for certain equipment using refrigerants containing hydrofluorocarbons and certain substitutes; use of reclaimed hydrofluorocarbons for the servicing and/or repair of certain refrigerant-containing equipment; the use of recycled hydrofluorocarbons for initial installation and servicing and/or repair of fire suppression equipment, technician training, and recycling of hydrofluorocarbons prior to the disposal of fire suppression equipment containing hydrofluorocarbons; removal of hydrofluorocarbons from disposable cylinders before discarding; and certain recordkeeping, reporting, and labeling requirements. In addition, EPA is establishing alternative Resource Conservation and Recovery Act standards for certain ignitable spent refrigerants being recycled for reuse.

DATES: This rule is effective **[INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER*]**.

FOR FURTHER INFORMATION CONTACT: Christian Wisniewski, Stratospheric Protection Division, Office of Atmospheric Protection (Mail Code 6205A), Environmental Protection Agency, 1200 Pennsylvania Ave. NW, Washington, DC 20460; telephone number: 202-564-0417; email address: *wisniewski.christian@epa.gov*. You may also visit EPA's website at *https://www.epa.gov/climate-hfcs-reduction* for further information.

For information related to the alternative standards for certain ignitable spent refrigerants under the Resource Conservation and Recovery Act (RCRA), please contact Tracy Atagi, Materials Recovery and Waste Management Division, Office of Resource Conservation and Recovery (5304T), Environmental Protection Agency, 1200 Pennsylvania Ave. NW, Washington, DC 20460; telephone number: (202) 566-0511; email address: *atagi.tracy@epa.gov*.

SUPPLEMENTARY INFORMATION:

Throughout this document whenever "we," "us," "the Agency," or "our" is used, we mean EPA.

Acronyms that are used in this rulemaking that may be helpful include:

AHRI – Air-Conditioning, Heating, and Refrigeration Institute
ALD – Automatic Leak Detection
AIM Act – American Innovation and Manufacturing Act of 2020
APF – Air Permitting Forum
APU – Auxiliary power unit
ASHRAE – American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM – American Society for Testing and Materials
BOEM – Bureau of Ocean Energy Management
BTU/h – British thermal units per hour
CAA – Clean Air Act
CARB – California Air Resources Board
CBI – Confidential Business Information
CFC – Chlorofluorocarbon

CFR – Code of Federal Regulations
CH_4 – Methane
CO_2 – Carbon dioxide
CO_2e – Carbon Dioxide Equivalent
DOD – Department of Defense
DOI – Department of the Interior
DOJ – Department of Justice
DOT – Department of Transportation
EEAP – Environmental Effects Assessment Panel
EO – Executive Order
EOL – End of Life
EPA – Environmental Protection Agency
ER&R – Emissions Reduction and Reclamation Program
EVe – Exchange Value Equivalent
FAA – Federal Aviation Administration
FEMA – Fire Equipment Manufacturers Association
F-HTFs – Fluorinated Heat Transfer Fluids
FOIA – Freedom of Information Act
FR – *Federal Register*
FSSA – Fire Suppression Systems Association
GHG – Greenhouse gas
GHGRP – Greenhouse Gas Reporting Program
GWP – Global Warming Potential
HARC – Halon Alternatives Research Corporation
HCFC – Hydrochlorofluorocarbon
HCFO – hydrochlorofluoroolefin
HEEP – HFC Emissions Estimating Program
HFC – Hydrofluorocarbon
HFO – Hydrofluoroolefin
HSWA – Hazardous and Solid Waste Amendments of 1984
HVAC – Heating, Ventilation, and Air Conditioning
HVACR – Heating, air conditioning, and refrigeration
ICR – Information Collection Request
in-Hg – inches of Mercury
IPCC – Intergovernmental Panel on Climate Change
IPR – Industrial Process Refrigeration
LRM – Lifecycle refrigerant management
MACS – Mobile Air Climate Systems Association
$MMTCO_2e$ – Million Metric Tons of Carbon Dioxide Equivalent
MMTEVe – Million Metric Tons of Exchange Value Equivalent
MVAC – Motor Vehicle Air Conditioner
NAICS – North American Industrial Classification System
NAFED – National Association of Fire Equipment Distributors
NEDA/CAP – National Environmental Development Association's Clean Air Project
NFPA – National Fire Protection Association

NODA – Notice of Data Availability
NRDC – Natural Resources Defense Council
NTTAA – National Technology Transfer and Advancement Act
OCS – Outer Continental Shelf
OCSLA – Outer Continental Shelf Lands Act
ODP – Ozone Depletion Potential
ODS – Ozone-depleting substances
OEM – Original Equipment Manufacturer
OMB – Office of Management and Budget
PII – Personally identifiable information
ppm – Parts Per Million
PRA – Paperwork Reduction Act
PTAC – Packaged terminal air conditioners
R4 Program – Refrigerant Recovery, Reclaim, and Reuse Requirements (CARB Program)
RACA – Request for Additional Consumption Allowance
RACHP – Refrigeration, Air Conditioning, and Heat Pumps
RCOP – Recycling Code of Practice
RCRA – Resource Conservation and Recovery Act
RFA – Regulatory Flexibility Act
RIA – Regulatory Impact Analysis
SAE – Society of Automotive Engineers
SC-HFC – Social Cost of Hydrofluorocarbons
SISNOSE – Significant Economic Impact on a Substantial Number of Small Entities
SNAP – Significant New Alternatives Policy
TFA – Trifluoracetic acid
TSD – Technical Support Document
UMRA – Unfunded Mandates Reform Act
VCOP – Voluntary Code of Practice
VRF – Variable Refrigerant Flow
VSQG – Very Small Quantity Generator

Table of Contents

K. Congressional Review Act (CRA)

I. Executive Summary

A. What is the purpose of these regulations?

The Environmental Protection Agency (EPA) is issuing regulations to implement certain provisions of the American Innovation and Manufacturing Act of 2020, codified at 42 U.S.C. 7675 (AIM Act or "the Act"). The AIM Act authorizes EPA to address hydrofluorocarbons (HFCs) in three main ways: phasing down HFC production and consumption through an allowance allocation program;[1] facilitating the transition to next-generation technologies by restricting use of these HFCs in the sector or subsectors in which they are used;[2] and promulgating certain regulations for purposes of maximizing reclaiming and minimizing releases of HFCs from equipment and ensuring the safety of technicians and consumers. This rulemaking focuses on the third area – establishing certain regulations for HFCs and their substitutes for the purposes of maximizing reclaiming and minimizing releases of HFCs from equipment and ensuring the safety of technicians and consumers.

More specifically, subsection (h) of the AIM Act, titled "Management of Regulated Substances," directs EPA to promulgate regulations to control, where appropriate, any practice,

[1] EPA has issued regulations establishing and codifying a framework for phasing down HFC production and consumption through an allowance allocation program, "Phasedown of Hydrofluorocarbons: Establishing the Allowance Allocation and Trading Program Under the American Innovation and Manufacturing Act" (86 FR 55116, October 5, 2021) – referred to as the "Allocation Framework Rule" throughout this document. EPA finalized a separate rulemaking to update certain aspects of that regulatory framework (see final rule at 88 FR 46836, July 20, 2023) – referred to as the "2024 Allocation Rule" throughout this document.

[2] EPA has issued regulations addressing the framework for how EPA intends to implement its authority to restrict the use of HFCs in sectors and subsectors where they are used, as well as establishing certain restrictions on the use of HFCs in specific sectors or subsectors in which they are used, "Phasedown of Hydrofluorocarbons: Restrictions on the Use of Certain Hydrofluorocarbons Under the American Innovation and Manufacturing Act of 2020" (88 FR 73068, October 24, 2023) – referred to as the "2023 Technology Transitions Rule" throughout this document. EPA issued an interim final rule under the Technology Transitions program further addressing a particular subsector (88 FR 88825, December 26, 2023).

process, or activity regarding the servicing, repair, disposal, or installation of equipment that involves: a regulated substance (used interchangeably with "HFCs" in this rulemaking), a substitute for a regulated substance, the reclaiming of a regulated substance used as a refrigerant, or the reclaiming of a substitute for a regulated substance used as a refrigerant.

This rulemaking establishes the Emissions Reduction and Reclamation (ER&R) Program to implement the provisions of subsection (h), including its authority to issue regulations to control such practices, processes, or activities, particularly as related to the management, use, and reuse of HFCs and substitutes in equipment. Further, these regulations include provisions to support implementation of, compliance with, and enforcement of requirements under subsection (h) of the AIM Act.

Additionally, EPA is establishing alternative RCRA standards for certain ignitable spent refrigerants being recycled for reuse, as that term is used under RCRA.[3] These standards involve regulatory changes to 40 Code of Federal Regulations (CFR) parts 261 through 271 and are separate from the regulations under subsection (h)(1) of the AIM Act. These standards are established under a different set of statutory authorities than the ER&R regulations, and they are part of an independent and distinct regulatory regime. EPA is providing notice of the AIM Act regulations and the RCRA regulations in one **Federal Register** (FR) notice given both the RCRA regulations concerning the recovery and recycling of certain ignitable spent refrigerants and the AIM Act regulations concerning recovery and reclamation of refrigerants may be of interest to some of the same stakeholders.

[3] The terms "reclaim" and "recycle" have different regulatory purposes and definitions under RCRA than under the CAA and the AIM Act. Under RCRA, a material is "reclaimed" if it is processed to recover a usable product, or if it is regenerated. Examples are recovery of lead values from spent batteries and regeneration of spent solvents (See 40 CFR 261.1(c)(4)). Reclamation is one of the four types of "recycling" identified in 40 CFR 261.2(c) that can involve management of a solid waste under RCRA.

B. What is the summary of the regulations finalized in this notice?

EPA is promulgating two separate and distinct sets of regulations. First, EPA is establishing an ER&R program for the management of HFCs and certain substitutes under subsection (h) of the AIM Act. The Agency is including provisions that address the purposes identified in subsection (h)(1) of the AIM Act of maximizing reclamation, minimizing the release of HFCs from equipment, and ensuring the safety of technicians and consumers. Specifically, the AIM Act regulations include requirements for:

- Leak repair of appliances that contain at least 15 pounds of a refrigerant that contains an HFC or a substitute for an HFC with a global warming potential (GWP) above 53, with specific exceptions;
- Installation and use of an automatic leak detection (ALD) system for certain new and existing appliances containing 1,500 pounds or more of a refrigerant that contains an HFC or a substitute for an HFC with a GWP above 53;
- A reclamation standard limiting the amount of virgin HFCs that can be contained in reclaimed HFC refrigerants;
- The use of reclaimed HFCs in certain refrigeration, air conditioning, and heat pumps (RACHP) subsectors for the servicing and/or repair of existing equipment;
- The servicing, repair, disposal, or installation of fire suppression equipment that contains HFCs, with the purpose of minimizing the release of HFCs from that equipment, including requirements for the use of recycled HFCs for the initial installation and servicing and/or repair of fire suppression equipment, as well as requirements related to technician training in the fire suppression sector;

- Recovery of HFCs from disposable cylinders before discarding; and
- Recordkeeping, reporting, and labeling.

Enforcement and compliance. To support compliance with these requirements, EPA is establishing labeling, reporting, and recordkeeping requirements as described in this rulemaking notice. The Agency intends to use the same reporting platform used in prior AIM Act rules and the Greenhouse Gas Reporting Program (GHGRP).[4]

Exemptions for certain applications and other provisions. Provisions finalized in this action do not apply to two applications, mission-critical military end uses and onboard aerospace fire suppression, as listed at section 84.13(a), for a year or years for which that application receives an application-specific allowance as defined at section 84.3. As such, the provisions established in this action include exemptions for the following applications, for a year or years for which that application receives an application-specific allowance:

- Mission-critical military end uses and
- Onboard aerospace fire suppression.

Amendments to the RCRA hazardous waste regulations. Second, EPA is amending a separate set of regulations promulgated under RCRA, a separate statutory authority from the AIM Act, to establish alternative standards for ignitable spent refrigerants when "recycled for reuse," as the term is to be defined under RCRA. EPA is establishing that the alternative standards at 40 CFR part 266, subpart Q, RCRA, apply to HFCs and other substitutes that are lower flammability (i.e., that do not belong to flammability Class 3 as classified by the American Society of Heating,

[4] The GHGRP requires reporting of greenhouse gas (GHG) data and other relevant information from large GHG emission sources, fuel and industrial gas suppliers, and carbon dioxide (CO_2) injection sites in the United States. Publicly available information includes facility names, addresses, and latitude/longitude information.

Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 34–2022.)[5] EPA is limiting the alternative standards to lower flammability HFCs and substitutes (Class 1, 2, and 2L) because of the lower risk of fire from the collection and recycling for reuse of these refrigerants, and the greater market value of these refrigerants, which supports the conclusion that these spent refrigerants will be recycled for reuse and not stockpiled, mismanaged, or abandoned.

Other topics. Before proposing this rule, EPA issued an advanced notice of proposed rulemaking (ANPRM) seeking information on approaches for establishing requirements for technician training and/or certification. As stated at proposal, EPA is not addressing technician training in this final rulemaking and accordingly is not responding to comments on the ANPRM in this final rule.

Additionally, EPA is not finalizing as part of this action under the AIM Act the proposed provisions for container tracking of HFCs that could be used in the servicing, repair, and/or installation of refrigerant-containing or fire suppression equipment. EPA is also not finalizing in this action provisions for the use of reclaimed HFCs for the initial installation of refrigerant-containing equipment in certain subsectors in the RACHP sector where HFCs or a blend containing HFCs are used. The Agency intends to further consider those provisions and the comments submitted on the proposed requirements before determining how to proceed. As such, EPA need not respond to public comments on those proposed requirements as part of this action.

[5] ASHRAE Standard 34–2022 assigns a safety group classification for each refrigerant that consists of two alphanumeric characters (*e.g.*, A2 or B1). The capital letter indicates the toxicity class ("A" for lower toxicity) and the numeral denotes the flammability. ASHRAE recognizes three classifications and one subclass for refrigerant flammability. The three main flammability classifications are Class 1, for refrigerants that do not propagate a flame when tested as per the ASHRAE 34 standard, "Designation and Safety Classification of Refrigerants;" Class 2, for refrigerants of lower flammability; and Class 3, for highly flammable refrigerants, such as the hydrocarbon refrigerants. ASHRAE recently updated the safety classification matrix to include a new flammability subclass 2L, for flammability Class 2 refrigerants that burn very slowly.

EPA received many comments on this rulemaking, including those that were in general support or opposition of the various provisions. Specific comments as relevant to provisions in this rulemaking are discussed in the respective sections of this rulemaking. Some comments raised issues that are beyond the scope of this rulemaking; because those comments require no response, EPA need not address them in this notice, though in many cases the Agency has noted the submission of such comments for informational purposes.

C. What is the summary of the costs and benefits?

The costs and benefits for the provisions related to managing regulated substances and their substitutes in this rule comes from the *Analysis of the Economic Impact and Benefits of the Final Rule: Management of Certain Hydrofluorocarbons and Substitutes Under Subsection (h) of the American Innovation and Manufacturing Act of 2020* technical support document (TSD) (referred to as the "Economic Impact and Benefits TSD" in this rule) and the regulatory impact analysis (RIA) addendum to the Allocation Framework Rule contained in the docket of this rule to provide the public with information on the relevant costs and benefits of this action, and to comply with executive orders (EOs). EPA notes that the costs and benefits associated with the management of regulated substances and their substitutes under the AIM Act are described and calculated separately from those associated with the amendments to the RCRA hazardous waste regulations. These analyses—as summarized later in this section—highlight the economic costs and benefits of the provisions in this rulemaking.

Given that the provisions being finalized concern the management of HFCs, and HFCs are subject to the phasedown of production and consumption under the AIM Act, the Agency relied on its previous analyses as a starting point for the assessment of costs and benefits of this rule. Specifically, the Allocation Framework Rule, "Phasedown of Hydrofluorocarbons:

Establishing the Allowance Allocation and Trading Program Under the American Innovation and Manufacturing Act" (86 FR 55116, October 5, 2021), the 2024 Allocation Rule, "Phasedown of Hydrofluorocarbons: Allowance Allocation Methodology for 2024 and Later Years" (88 FR 46836, July 20, 2023),[6] and the 2023 Technology Transitions Rule, "Phasedown of Hydrofluorocarbons: Restrictions on the Use of Certain Hydrofluorocarbons Under the American Innovation and Manufacturing Act of 2020" (88 FR 73098, October 24, 2023) are assumed as a baseline for this rule. In this way, EPA analyzed the potential incremental impacts of the rule, attributing benefits only insofar as they are additional to those already assessed in the Allocation Framework Rule RIA, the 2024 Allocation Rule RIA Addendum, and the 2023 Technology Transitions Rule RIA Addendum (collectively referred to as "Allocation and 2023 Technology Transitions Rules" in this discussion).

As detailed in the RIA addendum and the Economic Impact and Benefits TSD, the number, charge sizes, leak rates, and other characteristics of potentially affected RACHP equipment were estimated using EPA's Vintaging Model.[7] These estimates served as a basis for calculating the reductions in HFC consumption and emissions from the various requirements of the final rule. As described in the RIA addendum and the Economic Impact and Benefits TSD, the leak repair and ALD system provisions finalized in this rule are assumed to result in the repair of leaking systems earlier than they otherwise would have, leading to reduced emissions of

[6] This rule established the methodology for allocating HFC production and consumption allowances starting with calendar year 2024 allowances and adjusted the consumption baseline downward by less than 0.5 percent to reflect corrected data, among other changes (88 FR 46836, July 20, 2023). EPA also finalized another rulemaking in 2023 to update the regulations established in the HFC Allocation Framework Rule. That rule "Phasedown of Hydrofluorocarbons: Adjustment to the Hydrofluorocarbon Baseline," amended the production baseline downward by 0.005 percent to reflect corrected data (88 FR 44220, July 12, 2023).
[7] U.S. EPA. 2023. EPA's Vintaging Model representing the Allocation Framework Rule as modified by the 2024 Allocation Rule RIA addendum and the 2023 Technology Transitions Rule RIA Addendum. VM IO file_v4.4_02.04.16_Final TT Rule 2023 High Addition.

HFCs. Provisions requiring the use of reclaimed refrigerant, requirements for the fire suppression sector, and provisions related to the handling of disposable cylinders are further estimated to result in incremental reductions in HFC emissions.

Estimated reductions in HFC releases from equipment result in climate benefits due to reduced climate forcing, which have been monetized in the RIA addendum by multiplying avoided emissions by estimates of the social cost of each HFC (collectively referred to as SC-HFC) affected by the rule. The RIA addendum includes these SC-HFC estimates and uses them in some of the analyses for the purpose of providing information to the public and to comply with EOs. Although we utilized the SC-HFC estimates for purposes of those analyses, this action does not rely on those values or the resulting quantification of climate benefits as a record basis for this rule, and we would reach the same conclusions in absence of the social costs of HFCs. In the years 2026 through 2050, EPA estimates the rule will prevent approximately 120 million metric tons of carbon dioxide equivalent ($MMTCO_2e$) in HFC emissions, and the present value of economic benefit of avoiding the damages associated with those emissions is estimated at $8.4 billion (discounted to 2024 dollars using a three percent discount rate).[8] The annual benefits are estimated to decrease over time due to the HFC phasedown and the transition out of the higher-GWP HFCs, lowering the average GWP of later emissions. For example, it is estimated that the leak repair and ALD system provisions will prevent approximately 5.6 $MMTCO_2e$ of HFC emissions in 2030 and 3.0 $MMTCO_2e$ in 2040.

Reducing HFC emissions due to fixing leaks earlier is also anticipated to lead to savings for some system owners and operators, as less new refrigerant needs to be purchased to replace

[8] Unless stated otherwise, costs and benefits in this section are presented in 2022 dollars.

leaked refrigerant. In 2026, it is estimated that the leak repair and ALD provisions will lead to savings of $19.5 million (2022$) based on reduced HFC refrigerant needed to maintain the equipment. We also are aware that a refrigerant-containing appliances would operate less efficiently if not properly charged and maintained, leading to increased energy costs; however, we have not quantified such savings in our analysis. EPA acknowledges that these $19.5 million in savings may not completely offset leak repair compliance costs and may not accrue uniformly to all regulated entities. Further, while these provisions have been estimated to result in savings, EPA understands that entities that may be affected by these regulations might not perform the practices, processes, or activities that would result in cost savings absent regulation. When entities are reviewing their own economic analyses, some factors may be pertinent that make new technologies or economically favorable best practices less attractive than existing practices, or some market failure may exist that acts as a barrier to businesses' adoption of the most profitable course.[9] For example, market failures may exist where there is imperfect information or split incentives, such as decision-makers not knowing the percentage of energy use associated with refrigeration or the costs of replacing refrigerant lost from leaking appliances.

The compliance costs of the rule include recordkeeping and reporting costs, the costs of purchasing and operating ALD systems, costs of required inspections, the cost of repairing leaks earlier than would have been necessary without the provisions, the costs associated with using reclaimed HFCs in certain RACHP subsectors for the servicing of existing equipment (vis a vis virgin manufactured HFCs), the costs associated with minimizing releases of HFCs from fire

[9] Klemick, Heather & Kopits, Elizabeth & Wolverton, Ann. "Potential Barriers to Improving Energy Efficiency in Commercial Buildings: The Case of Supermarket Refrigeration." Journal of Benefit-Cost Analysis. 8, 2017, pp. 1–31.

suppression equipment (including using recycled HFCs in the initial and servicing and/or repair of fire suppression equipment), and the cost of disposable cylinder management requirements. In the years 2026 through 2050, these provisions would result in compliance costs (inclusive of refrigerant savings) with a present value estimated at $1.5billion (in 2022 dollars discounted to 2024) at a two percent discount rate, $1.3 billion at a three percent discount rate, or $0.9 billion at a seven percent discount rate.

Taking into account both benefits and compliance costs over the 2026 through 2050 time period, it is estimated that the rule results in present value net benefit (climate benefits, as monetized by application of SC-HFCs, discounted at three percent, minus compliance costs) of $6.9 billion (with compliance costs discounted at two percent) to $7.5 billion (with compliance costs discounted at seven percent).

As detailed in the RIA addendum and the *Economic Impact and Benefits* TSD, these values represent an estimate of potential incremental benefits and assume that industry would comply with previous AIM Act regulations as outlined in the 2023 Technology Transitions RIA Addendum[10] but would not undertake certain improvements to leak repair and refrigerant recovery practices in the absence of this rulemaking that were not required by those regulations. Since these assumptions are ultimately uncertain, in the RIA addendum and *the Economic Impact and Benefits* TSD, EPA has also provided estimates under an additional scenario in which leak repair and recovery improvements do occur in the baseline, thus resulting in lower incremental benefits. The assumptions in this alternative scenario translate into reduced estimates

[10] In the 2023 Technology Transitions RIA addendum, we analyzed a ”base case” and a ”high additionality” scenario. The former is used as the baseline to analyze the base case scenario for this rule. See the RIA addendum and Economic Impact and Benefits TSD for additional details.

of the incremental effect of the provisions of this final rule since additional impacts are only quantified insofar as they go beyond baseline assumptions of existing policy and industry practice.

Some of the information regarding projected impacts of certain aspects of the action was considered by EPA as it finalized this rulemaking. To the extent that EPA has considered such information, it is compiled in *the Economic Impact and Benefits* TSD, which is in the docket for this rulemaking. While EPA has included estimates of the costs and benefits of this rulemaking in the RIA addendum, to provide the public with information on the relevant costs and benefits of this action and to comply with Executive Orders, the analysis in the RIA addendum does not form a basis or rationale for any of the provisions EPA is promulgating in this rulemaking.

Further, as explained previously in this section, although EPA is using the SC-HFCs for purposes of some of the analysis in the RIA addendum, this action does not rely on those SC-HFC estimates as a record basis for the Agency's action. EPA would reach the conclusions in this rule even in the absence of the SC-HFCs. Additional information on these analyses can be found in section VI of this document, as well as the RIA addendum, which is in the docket for this rulemaking.

II. General information

A. Do these regulations apply to me?

You may be potentially affected by the regulations established in this final rule if you own, operate, service, repair, recycle, dispose, or install equipment containing HFCs or their substitutes, as well as if you recover, recycle, or reclaim HFCs or their substitutes. You may also be potentially affected if you manufacture or sell equipment containing HFCs or their substitutes.

Potentially affected categories, by North American Industrial Classification System (NAICS) code, are included in Table 1.

Table 1. NAICS Classification of Potentially Affected Entities

NAICS Code	NAICS Industry Description
236118	Residential Remodelers
236220	Commercial and Institutional Building Construction
238220	Plumbing, Heating, and Air-Conditioning Contractors
238990	All Other Specialty Trade Contractors
311812	Commercial Bakeries
321999	All Other Miscellaneous Wood Product Manufacturing
322299	All Other Converted Paper Product Manufacturing
324191	Petroleum Lubricating Oil and Grease Manufacturing
324199	All Other Petroleum and Coal Products Manufacturing
325199	All Other Basic Organic Chemical Manufacturing
325211	Plastics Material and Resin Manufacturing
325412	Pharmaceutical Preparation Manufacturing
325414	Biological Product (except Diagnostic) Manufacturing
325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing
326299	All Other Rubber Product Manufacturing
327999	All Other Miscellaneous Nonmetallic Mineral Product Manufacturing
332812	Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers
332999	All Other Miscellaneous Fabricated Metal Product Manufacturing
333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing
333511	Industrial Mold Manufacturing
333912	Air and Gas Compressor Manufacturing
333999	All Other Miscellaneous General Purpose Machinery Manufacturing
334413	Semiconductor and Related Device Manufacturing
334419	Other Electronic Component Manufacturing
334516	Analytical Laboratory Instrument Manufacturing
335220	Major Household Appliance Manufacturing
336120	Heavy-Duty Truck Manufacturing
336212	Truck Trailer Manufacturing
336214	Travel Trailer and Camper Manufacturing
3363	Motor Vehicle Parts Manufacturing
3364	Aerospace Product and Parts Manufacturing
336411	Aircraft Manufacturing

NAICS Code	NAICS Industry Description
336611	Ship Building and Repairing
336612	Boat Building
339112	Surgical and Medical Instrument Manufacturing
339113	Surgical Appliance and Supplies Manufacturing
339999	All Other Miscellaneous Manufacturing
423120	Motor Vehicle Supplies and New Parts Merchant Wholesalers
423450	Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers
423610	Electrical Apparatus and Equipment, Wiring Supplies, and Related Equipment Merchant Wholesalers
423620	Household Appliances, Electric Housewares, and Consumer Electronics Merchant Wholesalers
423690	Other Electronic Parts and Equipment Merchant Wholesalers
423720	Plumbing and Heating Equipment and Supplies (Hydronics) Merchant Wholesalers
423730	Warm Air Heating and Air-Conditioning Equipment and Supplies Merchant Wholesalers
423740	Refrigeration Equipment and Supplies Merchant Wholesalers
423830	Industrial Machinery and Equipment Merchant Wholesalers
423840	Industrial Supplies Merchant Wholesalers
423850	Service Establishment Equipment and Supplies Merchant Wholesalers
423860	Transportation Equipment and Supplies (except Motor Vehicle) Merchant Wholesalers
423990	Other Miscellaneous Durable Goods Merchant Wholesalers
424690	Other Chemical and Allied Products Merchant Wholesalers
424820	Wine and Distilled Alcoholic Beverage Merchant Wholesalers
441310	Automotive Parts and Accessories Stores
443141	Household Appliance Stores
444190	Other Building Material Dealers
445110	Supermarkets and Other Grocery (except Convenience) Stores
445131	Convenience Retailers
445298	All Other Specialty Food Retailers
446191	Food (Health) Supplement Stores
449210	Electronics and Appliance Retailers
452311	Warehouse Clubs and Supercenters
453998	All Other Miscellaneous Store Retailers (except Tobacco Stores)
45711	Gasoline Stations With Convenience Stores
481111	Scheduled Passenger Air Transportation
488510	Freight Transportation Arrangement
493110	General Warehousing and Storage
531120	Lessors of Nonresidential Buildings (except Mini warehouses)
541330	Engineering Services

NAICS Code	NAICS Industry Description
541380	Testing Laboratories
541512	Computer Systems Design Services
541519	Other Computer Related Services
541620	Environmental Consulting Services
561210	Facilities Support Services
561910	Packaging and Labeling Services
561990	All Other Support Services
562111	Solid Waste Collection
562211	Hazardous Waste Treatment and Disposal
562920	Materials Recovery Facilities
621498	All Other Outpatient Care Centers
621999	All Other Miscellaneous Ambulatory Health Care Services
72111	Hotels (Except Casino Hotels) and Motels
72112	Casino Hotels
72241	Drinking Places (Alcoholic Beverages)
722511	Full-service Restaurants
722513	Limited-service Restaurants
722514	Cafeterias, Grill Buffets, and Buffets
722515	Snack and Nonalcoholic Beverage Bars
81119	Other Automotive Repair and Maintenance
811219	Other Electronic and Precision Equipment Repair and Maintenance
811412	Appliance Repair and Maintenance
922160	Fire Protection

This table is not intended to be exhaustive, but rather provides a guide for readers regarding entities likely to be regulated by this rulemaking. This table lists the types of entities that EPA expects could potentially be regulated by this rulemaking. Other types of entities not listed in the table could also be regulated. To determine whether your entity may be regulated by this rulemaking, you should carefully examine the regulatory text at the end of this document. If you have questions regarding the applicability of these regulations to a particular entity, consult the people listed in the **FOR FURTHER INFORMATION CONTACT** section.

B. What is EPA's authority for these regulations?

On December 27, 2020, the AIM Act was enacted as section 103 in Division S, Innovation for the Environment, of the Consolidated Appropriations Act, 2021 (42 U.S.C. 7675). In subsection (k)(1)(A), the AIM Act provides EPA with the authority to promulgate necessary regulations to carry out EPA's functions under the Act, including its obligations to ensure that the Act's requirements are satisfied (42 U.S.C. 7675(k)(1)(A)). Subsection (k)(1)(C) of the Act also provides that Clean Air Act (CAA) sections 113, 114, 304, and 307 apply to the AIM Act and any regulations EPA promulgates under the AIM Act as though the AIM Act were part of Title VI of the CAA (42 U.S.C. 7675(k)(1)(C)). Accordingly, the promulgation of these regulations under the AIM Act is subject to CAA section 307(d) (see 42 U.S.C. 7607(d)(1)(I)) (CAA section 307(d) applies to "promulgation or revision of regulations under subchapter VI of this chapter ((relating to stratosphere and ozone protection))").

The AIM Act authorizes EPA to address HFCs in three main ways: phasing down HFC production and consumption through an allowance allocation program; facilitating the transition to next-generation technologies by restricting use of these HFCs in the sector or subsectors in which they are used; and promulgating certain regulations for purposes of maximizing reclaiming and minimizing releases of HFCs from equipment and ensuring the safety of technicians and consumers. This rulemaking focuses on the third area – establishing certain regulations for HFCs and their substitutes for the purposes of maximizing reclaiming[11] and minimizing releases of HFCs from equipment and ensuring the safety of technicians and consumers.

[11] For purposes of this provision, EPA views "reclaim," "reclaiming," and "reclamation" as similar terms and when used as nouns uses them interchangeably in this ER&R action.

The identification of regulated substances is addressed under subsection (c) of the Act. The Act lists 18 saturated HFCs, and by reference any of their isomers not so listed, which are covered by the statute's provisions and are referred to as "regulated substances"[12] under the Act (42 U.S.C. 7675(c)(1)). Congress also assigned an "exchange value"[13,14] to each regulated substance. EPA is also authorized to designate additional substances as regulated substances if they meet certain criteria; for example, to be listed, the substance must be a saturated HFC that has an exchange value greater than 53 (which is also the lowest exchange value for a regulated substance listed in subsection (c)(1) of the Act) (42 U.S.C. 7675(c)(3)).

The regulated substances addressed in this rulemaking may be used neat (*i.e.*, as a single component substance) or in a blend with other substances, which may include other regulated substances and/or substitutes for regulated substances. The requirements included in this rulemaking for regulated substances apply regardless of whether the regulated substance is used neat or in a blend. In taking this approach, EPA is not concluding that a blend that uses one or more regulated substances is itself a regulated substance. Rather, the Agency is intending to regulate the regulated substance(s) used within a "blend of substances" (42 U.S.C. 7675(c)(3)(B)(ii)), such that the requirements applicable to equipment that uses regulated

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[12] As noted previously in this action, "regulated substance" and "HFC" are used interchangeably in this ER&R action.

[13] EPA has determined that the exchange values included in subsection (c) of the AIM Act are identical to the GWPs included in the Intergovernmental Panel on Climate Change (IPCC) (2007). EPA uses the terms "global warming potential," "GWP," and "exchange value" interchangeably in this rulemaking.

[14] IPCC (2007): Solomon, S., D. Qin, M. Manning, R.B. Alley, T. Berntsen, N.L. Bindoff, Z. Chen, A. Chidthaisong, J.M. Gregory, G.C. Hegerl, M. Heimann, B. Hewitson, B.J. Hoskins, F. Joos, J. Jouzel, V. Kattsov, U. Lohmann, T. Matsuno, M. Molina, N. Nicholls, J. Overpeck, G. Raga, V. Ramaswamy, J. Ren, M. Rusticucci, R. Somerville, T.F. Stocker, P. Whetton, R.A. Wood and D. Wratt, 2007: Technical Summary. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA https://www.ipcc.ch/report/ar4/wg1. The IPCC's Fourth Assessment Report is also referred to as IPCC AR4.

substances also affect equipment that uses regulated substances in blends. This is consistent with approaches that the Agency has taken under the Allocation Framework Rule (86 FR 55116, October 5, 2021), the 2024 Allocation Rule (88 FR 46836, July 20, 2023), and the 2023 Technology Transitions Rule (88 FR 73098, October 24, 2023).[15] Furthermore, subsection (h)(1) requires EPA to promulgate regulations addressing certain practices, processes, or activities involving, among other things, a regulated substance or a substitute for a regulated substance (42 U.S.C. 7675(h)(1)(A)-(B)). Consistent with those provisions, regulatory requirements under subsection (h) may also apply with respect to substitutes for regulated substances, regardless of whether the substitute is used neat or in a blend. In taking this approach for substitutes for a regulated substance, EPA is not concluding that a blend that uses one or more such substitutes that are so regulated is itself a regulated substance under subsection (c) of the Act, nor is EPA designating the substitute a regulated substance under subsection (c) of the Act. Rather, such substitutes are simply addressed, as appropriate, under EPA's authority to promulgate regulations under subsection (h) for certain practices, processes, or activities that involve a substitute for a regulated substance.

Subsection (h) of the AIM Act is titled "Management of Regulated Substances." For purposes of maximizing reclaiming and minimizing releases of HFCs from equipment and ensuring the safety of technicians and consumers, subsection (h)(1) directs EPA to promulgate regulations to control, where appropriate, any practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment that involves a regulated substance, a

[15] In affirming this aspect of the Allocation Framework Rule, the D.C. Circuit held that "EPA has statutory authority to regulate HFCs within blends … because an HFC within a blend remains a regulated HFC under the Act." *Heating, Air Conditioning & Refrigeration Distributors Int'l v. EPA*, 71 F.4th 59, 64 (D.C. Cir. 2023).

substitute for a regulated substance, the reclaiming of a regulated substance used as a refrigerant, or the reclaiming of a substitute for a regulated substance used as a refrigerant (42 U.S.C. 7675(h)(1)). Subsection (h)(1) further provides that this includes requiring, where appropriate, that any such servicing, repair, disposal, or installation be performed by a trained technician meeting minimum standards, as determined by EPA.

Under subsection (h)(2)(A) of the AIM Act, the Agency "shall consider the use of authority available … under this section to increase opportunities for the reclaiming of regulated substances used as refrigerants." Subsection (h)(2)(B) of the Act further provides that a "regulated substance used as a refrigerant that is recovered shall be reclaimed before the regulated substance is sold or transferred to a new owner, except where the recovered regulated substance is sold or transferred to a new owner solely for the purposes of being reclaimed or destroyed."

Further, subsection (h)(3) provides that in promulgating regulations to carry out subsection (h), EPA may coordinate those regulations with "any other regulations promulgated by the [EPA] that involve – (A) the same or a similar practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment; or (B) reclaiming." EPA interprets this provision of the AIM Act as leaving the Agency discretion to choose whether to coordinate regulations under subsection (h) with other Agency regulations, as well as determine the circumstances in which it is appropriate to undertake such coordination. Congress did not define the term "coordinate" in the AIM Act. EPA interprets the term, as used in this context, as encompassing a variety of forms of coordination that could potentially be used for the specified types of regulatory provisions and interprets (h)(3) as conveying discretion to EPA to select the form or forms of coordination that are appropriate for the particular circumstances and regulatory provisions under consideration in a given action.

This action under subsection (h) of the AIM Act describes whether and where EPA is coordinating with regulations that involve the same or similar practices, processes, or activities regarding the servicing, repair, disposal, or installation of equipment or reclaiming, and the Agency's rationale on the appropriateness of coordinating with these regulations. For example, coordination could include establishing parallel requirements under subsection (h), where appropriate, as in another regulatory regime so that a similar practice, process, or activity in similar equipment is held to similar standards under both regimes. It could also include deciding not to establish requirements under subsection (h) in certain situations, such as when an existing requirement already applies to a similar practice, process, or activity under another set of regulations that EPA views as adequate to also address the purposes of subsection (h). Coordination could also mean coordinating rulemaking schedules or timing for certain requirements under subsection (h) that cover a similar practice, process, or activity as covered in a previous regulation and would meet the purposes of subsection (h). Finally, coordination may also mean coordinating the requirements under subsection (h) with revisions to regulations under other statutory authorities that address related practices, processes, or activities, with the goal of developing independent regulatory regimes that operate well together to achieve their stated goals.

Subsection (h)(4) expressly states that any rulemaking under subsection (h) shall not apply to a regulated substance or a substitute for a regulated substance that is contained in a foam. Thus, the requirements in this rulemaking do not apply to regulated substances or substitutes for regulated substances when those substances are contained in foams.

Finally, subsection (h)(5) provides that, subject to availability of appropriations, EPA shall establish a grant program to award small business grants for the purchase of new specialized equipment for the recycling, recovery, or reclamation of a substitute for a regulated substance, including the purchase of approved refrigerant recycling equipment for recycling, recovery, or reclamation in the service or repair of motor vehicle air conditioner (MVAC) systems. Funds have not been appropriated for this grant program. The establishment of this program is outside the scope of this rulemaking.

Through this rulemaking, EPA is establishing an ER&R program that includes requirements for leak repair for certain equipment containing a refrigerant that contains an HFC or certain substitutes for HFCs; installation and use of ALD systems for certain equipment; use of reclaimed HFCs in certain RACHP subsectors; use of recycled HFCs in the fire suppression sector, requirements for the servicing, repair, disposal, or installation of fire suppression equipment that contains HFCs, with the purpose of minimizing the release of HFCs from that equipment, as well as requirements related to technician training in the fire suppression sector; and recovery of HFCs from disposable cylinders before discarding. EPA is also establishing recordkeeping, reporting, and/or labeling requirements pursuant to these provisions.

Under subsection (h)(1), EPA is directed to promulgate certain regulations for "purposes of maximizing the reclaiming and minimizing the release of a regulated substance from equipment and ensuring the safety of technicians and consumers." Subsection (h) further specifies that those regulations are to control, where appropriate, any practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment that involves a regulated substance, a substitute for a regulated substance, the reclaiming of a regulated substance used as a refrigerant, or the reclaiming of a substitute for a regulated substance used as a refrigerant. Together, the provisions, as summarized here and explained in greater detail in the relevant sections of this rulemaking, are designed to further those three purposes described in subsection (h)(1); *i.e.*, (1) maximizing reclaiming, (2) minimizing the release of regulated substances from equipment, and (3) ensuring the safety of technicians and consumers, consistent with the scope of regulatory authority under that provision. As EPA interprets the statutory text, the suite of regulations established under subsection (h)(1) of the Act, taken together, are to focus on serving these purposes, though the individual regulatory provisions under subsection (h)(1) need not each connect to all three purposes. This interpretation is integral to establishing an effective regulatory program, as some regulatory provisions that might be considered under (h)(1) may be highly efficacious at addressing one of the regulatory purposes but not address the other two, or alternatively, may be important to support the functioning of the regulatory program as a whole, but not be focused on any of the specific purposes. Accordingly, this understanding of the statutory text will support EPA's ability to develop regulations that work together to help achieve the statutory purposes.

Together, the provisions in this action serve the purposes described in (h)(1), with certain provisions more geared towards one or two of the purposes identified in subsection (h)(1). For example, the provisions related to leak repair in this action are directed at the purpose of minimizing the release of a regulated substance from equipment, but also help serve the purpose of maximizing the reclaiming of a regulated substance. Those provisions set requirements for when and how equipment must be serviced and leaks in equipment must be repaired. Taking these actions will minimize the release of regulated substances through such leaks, as the sooner a leak is found and repaired, the less HFC will be released from that leak. Further, by limiting the amount of regulated substances released from leaks in equipment, the opportunity to recover and subsequently reclaim these regulated substances increases. Thus, the provisions related to leak repair also help serve the purpose of maximizing the reclaiming of regulated substances.

Another example is the provisions for the installation and use of ALD systems, which, similar to the leak repair provision, help address the purposes articulated in subsection (h)(1). In general, ALD systems will alert an owner or operator to leaks in refrigerant-containing appliances well before any measurable decrease in the level of performance of the equipment. Identifying and repairing leaks sooner as a result of detecting the leak with an ALD system will further limit the amount of regulated substance released from the leak and maintain more of the regulated substance within the equipment, where it will be available for eventual recovery and reclamation.

In addition to establishing requirements for the management of HFCs and substitutes, this action includes provisions designed to support enforcement and compliance, including recordkeeping and reporting. As stated earlier in this section, subsection (k)(1)(C) of the AIM Act states that CAA section 114 applies to the AIM Act and rules promulgated under it as if the AIM Act were included in CAA Title VI. Thus, CAA section 114, which provides authority to the EPA Administrator to require recordkeeping and reporting in carrying out provisions of the CAA, also applies to and supports this rulemaking. These provisions and ones like them are integral to establishing an effective regulatory program, and thus are important to the overall efficacy of the HFC management program at achieving the purposes articulated in subsection (h)(1), even if they may be less directly connected to those purposes if viewed in isolation.

EPA is also establishing alternative RCRA standards for ignitable spent refrigerants being recycled for reuse. These standards are not part of the regulations under subsection (h)(1) of the AIM Act but rather involve revisions to independent regulatory provisions, under a separate and distinct statutory authority. More specifically, the action under RCRA involves regulatory changes to 40 CFR parts 261 through 271, and those changes are made under the authority of sections 2002, 3001, 3002, 3003, 3004, 3006, and 3010 of the Solid Waste Disposal Act of 1965 (SWDA), as amended by the Resource Conservation and Recovery Act of 1976, as amended by the Hazardous and Solid Waste Amendments of 1984 (HSWA). This statute is commonly referred to as "RCRA."

III. Background

A. What are HFCs?

HFCs are anthropogenic[16] fluorinated chemicals that have no known natural sources. HFCs are used in a variety of applications such as refrigeration and air conditioning, foam-blowing agents, solvents, aerosols, and fire suppression. HFCs are potent greenhouse gases (GHGs) with 100-year GWPs (a measure of the relative climatic impact of a GHG) that can be hundreds to thousands of times more potent than carbon dioxide (CO_2).

HFC use and emissions[17] have been growing worldwide due to the global phaseout of ozone-depleting substances (ODS) under the *Montreal Protocol on Substances that Deplete the Ozone Layer* (Montreal Protocol) and the increasing use of refrigeration and air conditioning equipment globally. HFC emissions had previously been projected to increase substantially over the next several decades. In 2016, in Kigali, Rwanda, countries agreed to adopt an amendment to the Montreal Protocol, known as the Kigali Amendment, which provides for a global phasedown

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[16] While the overwhelming majority of HFC production is intentional, EPA is aware that HFC-23 can be a byproduct associated with the production of other chemicals, including but not limited to hydrochlorofluorocarbon (HCFC)-22.

[17] World Meteorological Organization (WMO), Scientific Assessment of Ozone Depletion: 2022, GAW Report No. 278, 509 pp., WMO, Geneva, Switzerland, 2022. Available at: *https://ozone.unep.org/system/files/documents/Scientific-Assessment-of-Ozone-Depletion-2022.pdf*.

of the production and consumption of HFCs. The United States ratified the Kigali Amendment on October 31, 2022. Global adherence to the Kigali Amendment will substantially reduce future emissions, leading to a peaking of HFC emissions before 2040.[18,19]

Atmospheric observations of most currently measured HFCs confirm their abundances are increasing at accelerating rates. Total emissions of HFCs increased by 23 percent from 2012 to 2016[20] and a further 19 percent from 2016 to 2020. The four most abundant HFCs in the atmosphere, in GWP-weighted terms, are HFC-134a, HFC-125, HFC-23, and HFC-143a.[21]

HFCs excluding HFC-23 accounted for a radiative forcing[22] of 0.025 W/m^2 in 2016, rising to 0.037 W/m^2 in 2020. This is an increase of nearly a third in total HFC forcing relative to 2016. This radiative forcing was projected to increase by an order of magnitude to 0.25 W/m^2 by 2050.[23] If the Kigali Amendment is fully implemented, it is expected to reduce the future radiative forcing due to HFCs (excluding HFC-23) to 0.13 W/m^2 in 2050, which is a reduction of about 50 percent compared with the radiative forcing projected in the business-as-usual scenario of uncontrolled HFCs.[24]

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[18] Ibid.

[19] A recent study estimated that global compliance with the Kigali Amendment is expected to lower 2050 annual emissions by 3.0–4.4 $MMTCO_2e$. Guus J.M. Velders et al. Projections of hydrofluorocarbon (HFC) emissions and the resulting global warming based on recent trends in observed abundances and current policies. Atmos. Chem. Phys., 22, 6087–6101, 2022. Available at: *https://doi.org/10.5194/acp-22-6087-2022*.

[20] World Meteorological Organization (WMO), Scientific Assessment of Ozone Depletion: 2018, World Meteorological Organization, Global Ozone Research and Monitoring Project—Report No. 58, 588 pp., Geneva, Switzerland, 2018. Available at: *https://ozone.unep.org/sites/default/files/2019-05/SAP-2018-Assessment-report.pdf*.

[21] WMO, 2022.

[22] Radiative forcing is expressed in units of watts per square meter (W/m^2) and is defined by the IPCC as “a measure of the influence a factor has in altering the balance of incoming and outgoing energy in the Earth-atmosphere system and is an index of the importance of the factor as a potential climate change mechanism.” IPCC, 2007: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp. *https://www.ipcc.ch/report/ar4/syr*.

[23] Guus J.M. Velders, David W. Fahey, John S. Daniel, Stephen O. Andersen, Mack McFarland, Future atmospheric abundances and climate forcings from scenarios of global and regional hydrofluorocarbon (HFCs) emissions, Atmospheric Environment, doi:10.1016/j.atmosenv.2015.10.071, 2015.

[24] Ibid.

There are hundreds of possible HFC compounds. The 18 HFCs listed as regulated substances by the AIM Act are some of the most commonly used HFCs (neat and in blends) and have high impacts as measured by the quantity of each substance emitted, multiplied by their respective GWPs. These 18 HFCs are all saturated, meaning they have only single bonds between their atoms, and therefore have longer atmospheric lifetimes.

In the United States, HFCs are used primarily in refrigeration and air-conditioning equipment in homes, commercial buildings, and industrial operations (approximately 75 percent of total HFC use in 2018) and in air conditioning in vehicles and refrigerated transport (approximately 8 percent). Smaller amounts are used in foam products (approximately 11 percent), aerosols (approximately 4 percent), fire protection systems (approximately 1 percent), and solvents (approximately 1 percent).[25]

EPA estimated in the Allocation Framework Rule (86 FR 55116, October 5, 2021) as updated under the 2024 Allocation Rule (88 FR 46836, July 20, 2023), that phasing down HFC production and consumption according to the schedule provided in the AIM Act will avoid cumulative consumption of 3,156 million metric tons of exchange value equivalent (MMTEVe) of HFCs in the United States for the years 2022 through 2036. That estimate included both consumption as defined in 40 CFR 84.3 – *i.e.*, with respect to a regulated substance, bulk

[25] Calculations based on EPA's Vintaging Model, which estimates the annual chemical emissions from industry sectors that historically used ODS, including refrigeration and air conditioning, foam blowing agents, solvents, aerosols, and fire suppression. The model uses information on the market size and growth for each end-use, as well as a history and projections of the market transition from ODS to substitutes. The model tracks emissions of annual "vintages" of new equipment that enter into operation by incorporating information on estimates of the quantity of equipment or products sold, serviced, and retired or converted each year, and the quantity of the compound required to manufacture, charge, and/or maintain the equipment. Additional information on these estimates is available in U.S. EPA, April 2016. EPA Report EPA-430-R-16-002. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2014. Available at: *https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2014*.

production plus bulk imports minus bulk exports – and, although not requiring AIM Act allowances, the amount in imported products containing a regulated substance, less the amount in exported products containing a regulated substance. Annual avoided consumption was estimated at 42 MMTCO_2e in 2022 and 282 MMTCO_2e in 2036. In order to calculate the climate benefits associated with consumption abatement, the consumption changes were expressed in terms of emissions reductions. EPA estimated that for the years 2022 through 2050, the HFC phasedown will avoid emissions of 4,560 MMTCO_2e of HFCs in the United States. The annual avoided emissions are estimated at 22 MMTCO_2e in the year 2022 and 171 MMTCO_2e in 2036. More information regarding these estimates is provided in the Allocation Framework Rule RIA and the 2024 Allocation Rule RIA Addendum, which can be found in the docket for this rulemaking.

The Agency calculated incremental avoided consumption and emissions under the 2023 Technology Transitions Rule (88 FR 73098, October 24, 2023). HFC consumption reductions beyond those from the HFC phasedown as stipulated in the previous paragraph ranged from 720 to 1,113 MMTCO_2e for the years 2025 through 2050. EPA also estimated that the 2023 Technology Transitions Rule will achieve an additional 83 to 876 MMTCO_2e of avoided emissions over these years, 2025 through 2050. The 2023 Technology Transitions Rule RIA Addendum, as well as the TSD, *Costs and Environmental Impacts*, are available in the docket for this rulemaking.

B. How do HFCs affect public health and welfare?

Elevated concentrations of GHGs including HFCs are and have been warming the planet, leading to changes in the Earth's climate including changes in the frequency and intensity of heat waves, precipitation, and extreme weather events; rising seas; and retreating snow and ice. The changes taking place in the atmosphere as a result of the well-documented buildup of GHGs due to human activities are changing the climate at a pace and scale that threatens human health, society, and the natural environment. This section provides some scientific background on climate change to offer additional context for this rulemaking and help the public understand the environmental impacts of GHGs, such as HFCs. Extensive additional information on climate change is available in the scientific assessments and Agency documents that are briefly described in this section, as well as in the technical and scientific information supporting them.

One of those documents is EPA's 2009 Endangerment and Cause or Contribute Findings for Greenhouse Gases under CAA section 202(a) (74 FR 66496, December 15, 2009).[26] In the 2009 Endangerment Finding, the Administrator found under CAA section 202(a) that elevated atmospheric concentrations of six key, well-mixed GHGs—CO_2, methane (CH_4), nitrous oxide (N_2O), HFCs, perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6)—"may reasonably be anticipated to endanger the public health and welfare of current and future generations" (74 FR 66523, December 15, 2009), and subsequent science and observed changes have confirmed and strengthened the understanding and concerns regarding the climate risks considered in the Finding. The 2009 Endangerment Finding, together with the extensive scientific and technical evidence in the supporting record, documented that climate change caused by human emissions of GHGs (including HFCs) threatens the public health of the population of the United States. It explained that by raising average temperatures, climate change increases the likelihood of heat waves, which are associated with increased deaths and illnesses (74 FR 66497, December 15, 2009). While climate change also likely reduces cold-related mortality, evidence indicates that

[26] In describing these 2009 Findings, EPA is neither reopening nor revisiting them.

the increases in heat mortality will be larger than the decreases in cold mortality in the United States (74 FR 66525, December 15, 2009). The 2009 Endangerment Finding further explained that, compared with a future without climate change, climate change is expected to increase tropospheric ozone pollution over broad areas of the United States, including in the largest metropolitan areas with the worst tropospheric ozone problems, and thereby increase the risk of adverse effects on public health (74 FR 66525, December 15, 2009). Climate change is also expected to cause more intense hurricanes and more frequent and intense storms of other types and heavy precipitation, with impacts on other areas of public health, such as the potential for increased deaths, injuries, infectious and waterborne diseases, and stress-related disorders (74 FR 66525, December 15, 2009). Children, elderly people, and poor people are among the most vulnerable to these climate-related health effects (74 FR 66498, December 15, 2009).

The 2009 Endangerment Finding also documented, together with the extensive scientific and technical evidence in the supporting record, that climate change touches nearly every aspect of public welfare[27] in the United States, including changes in water supply and quality due to increased frequency of drought and extreme rainfall events; increased risk of storm surge and flooding in coastal areas and land loss due to inundation; increases in peak electricity demand and risks to electricity infrastructure; predominantly negative consequences for biodiversity and the provisioning of ecosystem goods and services; and the potential for significant agricultural disruptions and crop failures (though offset to some extent by carbon fertilization). These impacts are also global and may exacerbate problems outside the United States that raise

[27] The CAA states in section 302(h) that "[a]ll language referring to effects on welfare includes, but is not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants." 42 U.S.C. 7602(h).

humanitarian, trade, and national security issues for the United States (74 FR 66530, December 15, 2009).

In 2016, the Administrator similarly issued Endangerment and Cause or Contribute Findings for GHG emissions from aircraft under CAA section 231(a)(2)(A) (81 FR 54422, August 15, 2016).[28] In the 2016 Endangerment Finding, the Administrator found that the body of scientific evidence amassed in the record for the 2009 Endangerment Finding compellingly supported a similar endangerment finding under CAA section 231(a)(2)(A) and also found that the science assessments released between the 2009 and the 2016 Endangerment Findings "strengthen and further support the judgment that GHGs in the atmosphere may reasonably be anticipated to endanger the public health and welfare of current and future generations" (81 FR 54424, August 15, 2016).

Since the 2016 Endangerment Finding, the climate has continued to change, with new records being set for several climate indicators such as global average surface temperatures, GHG concentrations, and sea level rise. Moreover, heavy precipitation events have increased in the Eastern United States, while agricultural and ecological drought has increased in the Western United States, along with more intense and larger wildfires.[29] These and other trends are examples of the risks discussed in the 2009 and 2016 Endangerment Findings that have already been experienced. Additionally, major scientific assessments continue to demonstrate advances in our understanding of the climate system and the impacts that GHGs have on public health and welfare both for current and future generations. According to the Intergovernmental Panel on Climate Change's (IPCC) Sixth Assessment Report, "it is unequivocal that human influence has

[28] In describing these 2016 Findings, EPA is neither reopening nor revisiting them.
[29] An additional resource for indicators can be found at *https://www.epa.gov/climate-indicators*.

warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred."[30] These updated observations and projections document the rapid rate of current and future climate change both globally and in the United States.[31,32]

C. What regulatory programs addressing refrigerants has EPA already established under the Clean Air Act?

EPA is issuing regulations that are designed to establish a comprehensive HFC management program that serves purposes including maximizing HFC reclamation and minimizing the release of HFCs from equipment while coordinating these efforts with other similar programs where appropriate. EPA has an extensive history under CAA Title VI regulating the sectors in which HFCs and substitutes are typically used, including where they are used as refrigerants and for other purposes. For example, EPA has regulated stationary refrigeration and air conditioning applications under CAA section 608, as well as MVACs under CAA section 609, and has evaluated alternative substances for refrigeration, air conditioning, and other uses under the Significant New Alternatives Policy (SNAP) program under CAA section 612.

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[30] IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 3−32, doi:10.1017/9781009157896.001.

[31] USGCRP, 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018. Available at: *https://nca2018.globalchange.gov*.

[32] IPCC, 2021.

1. National Recycling and Emission Reduction Program (CAA section 608)

CAA section 608, titled "National Recycling and Emission Reduction Program," has three main components. First, CAA section 608(a) requires EPA to establish standards and requirements regarding the use and disposal of class I and class II substances.[33] The second component, CAA section 608(b), requires that the regulations issued pursuant to subsection (a) contain requirements for the safe disposal of class I and class II substances. The third component, CAA section 608(c), prohibits the knowing venting, release, or disposal of ODS refrigerants[34] and their substitutes[35] in the course of maintaining, servicing, repairing, or disposing of appliances or industrial process refrigeration (IPR). EPA refers to this third component as the "venting prohibition." CAA section 608(c)(1) establishes the venting prohibition for ODS refrigerants effective July 1, 1992, and it includes an exemption from this prohibition for "[d]e minimis releases associated with good faith attempts to recapture and recycle or safely dispose" any such substance. CAA section 608(c)(2) extends CAA section 608(c)(1) to substitute refrigerants, effective November 15, 1995. CAA section 608(c)(2) also includes a provision that allows the Administrator to exempt a substitute refrigerant from the venting prohibition if he or she determines that such venting, release, or disposal of a substitute refrigerant "does not pose a threat to the environment."

EPA first issued regulations under CAA section 608 on May 14, 1993 (58 FR 28660, "1993 Rule"), to establish the national refrigerant management program for ODS refrigerants recovered during the service, repair, or disposal of air conditioning and refrigeration appliances.

[33] A class I or class II substance is an ozone-depleting substance (ODS) listed at 40 CFR part 82, subpart A, appendix A or appendix B, respectively. This document refers to class I and class II substances collectively as ODS.
[34] The term "ODS refrigerant" as used in this document refers to any refrigerant or refrigerant blend in which one or more of the components is a class I or class II substance.
[35] The term "substitute" for the purposes of the regulations under CAA section 608 is defined at 40 CFR 82.152.

Since then, EPA has revised these regulations, which are found at 40 CFR part 82, subpart F, ("subpart F"), through subsequent rulemakings published between 1994 and 2020. Regulations issued under CAA section 608 include, among other things, the venting prohibition and sales restrictions for refrigerants (40 CFR 82.154); safe disposal of appliances (40 CFR 82.155); proper practices for the evacuation of refrigerant from appliances (40 CFR 82.156); required practices for appliance maintenance and leak repair (40 CFR 82.157); standards for recovery and/or recycling equipment (40 CFR 82.158); technician and reclaimer certification requirements (40 CFR 82.161 and 82.164, respectively); and reporting and recordkeeping requirements (40 CFR 82.166). Appendices A through E at 40 CFR part 82, subpart F, provide, among other things, specifications for refrigerants; performance standards for refrigerant recovery, recycling, and/or reclaiming equipment; and standards for becoming a certifying program for technicians.

As it pertains to regulations under CAA section 608, EPA has used the term "non-exempt substitute" to refer to non-ozone depleting refrigerants that have not been exempted from the venting prohibition under CAA section 608(c)(2) and 40 CFR 82.154(a) in the relevant end use. Similarly, the term "exempt substitute" refers to a non-ozone depleting refrigerant that has been exempted from the venting prohibition under CAA section 608(c)(2) and 40 CFR 82.154(a) in the relevant end use. A few exempt substitutes have been exempted from the venting prohibition in all applications. Notably, in 2016, EPA updated existing refrigerant management requirements and extended the full set of the subpart F refrigerant management requirements, which prior to that rule applied only to ODS refrigerants,[36] to non-exempt substitute refrigerants, such as HFCs

[36] The only 40 CFR part 82, subpart F requirements that applied to substitute refrigerants prior to the 2016 CAA Section 608 Rule were the venting prohibition and certain exemptions from that prohibition, as set forth in section 82.154(a).

and hydrofluoroolefins (HFOs). See 81 FR 82272 (November 18, 2016), hereafter "2016 CAA Section 608 Rule." Among the subpart F requirements extended to non-exempt substitute refrigerants in the 2016 CAA Section 608 Rule were provisions that restricted the servicing of appliances and the sale of refrigerant to certified technicians; specified the proper evacuation levels before opening an appliance; required the use of certified refrigerant recovery and/or recycling equipment; required refrigerant be recovered from appliances prior to disposal; required appliances have a servicing aperture or process stub to facilitate refrigerant recovery; required refrigerant reclaimers be certified to reclaim and sell used refrigerant; and established standards for technician certification programs, recovery equipment, and the purity of reclaimed refrigerant. The 2016 CAA Section 608 Rule also extended the appliance maintenance and leak repair provisions, currently codified at 40 CFR 82.157, to appliances that contain 50 or more pounds of non-exempt substitute refrigerant. It also made numerous revisions to improve the efficacy of the refrigerant management program as a whole, such as revisions of regulatory provisions for increased clarity and readability, and removal of provisions that had become obsolete.

After promulgation, the Agency reviewed the 2016 CAA Section 608 Rule, focusing in particular on whether the Agency had the statutory authority to extend the full set of subpart F refrigerant management regulations to non-exempt substitute refrigerants, such as HFCs and HFOs. In 2018, EPA proposed to withdraw the extension of the provisions of 40 CFR 82.157 to appliances using only non-exempt substitute refrigerants (83 FR 49332, October 1, 2018).[37] In 2020, EPA published a final rule (85 FR 14150, March 11, 2020, hereafter "2020 CAA Section

[37] Ozone-depleting refrigerants and appliances that contain or use any amount of ODS continue to be subject to all applicable subpart F requirements, including those in 40 CFR 82.157.

608 Rule") withdrawing the extension of the leak repair requirements—including requirements for repairing leaks, conducting leak inspections, and keeping applicable records—for appliances containing only such substitute refrigerants. Other subpart F provisions that were extended to substitute refrigerants in the 2016 CAA Section 608 Rule, as mentioned in the previous paragraph, were left in place for appliances containing HFCs and other non-exempt substitute refrigerants. There were no changes to any of the regulatory requirements for ODS in the 2020 CAA Section 608 Rule.

Petitions for judicial review were filed on the 2016 CAA Section 608 Rule and separately on the 2020 CAA Section 608 Rule. Two industry coalitions, the National Environmental Development Association's Clean Air Project (NEDA/CAP) and the Air Permitting Forum (APF), filed petitions for judicial review of the 2016 CAA Section 608 Rule in the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit) in 2017. APF also filed an administrative petition for reconsideration before EPA regarding the 2016 CAA Section 608 Rule.[38] In 2020, the Natural Resources Defense Council (NRDC) and a group of state and municipal petitioners[39] filed petitions for judicial review of the 2020 CAA Section 608 Rule in the D.C. Circuit. NEDA/CAP also filed an administrative petition regarding the 2020 CAA Section 608 Rule, styled as a petition for reconsideration or in the alternative a petition for rulemaking.[40] These four petitions for review were all consolidated (Case No. 20-1150, D.C. Cir.) in July of 2020, and in August of 2020 the court severed four issues raised in NEDA/CAP

[38] APF Petition for Reconsideration, January 2017, available: *https://www.regulations.gov/document?D=EPA-HQ-OAR-2015-0453-0228*.

[39] The State and municipal petitioners are the State of New York, State of Connecticut, State of Illinois, State of Maine, State of Maryland, State of Minnesota, State of New Jersey, State of Oregon, Commonwealth of Virginia, State of Washington, District of Columbia, and City of New York.

[40] NEDA/CAP Petitions for Reconsideration/Petition for Rulemaking, May 2020, available: *https://www.regulations.gov/document?D=EPA-HQ-OAR-2017-0629-0345*.

and APF's administrative petitions for reconsideration and assigned them to a different case (Case No. 20-1309, D.C. Cir.). Both cases are now being held in abeyance.

The E.O. issued on January 20, 2021, "Executive Order on Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis," directed review of certain agency actions taken between January 20, 2017, and January 20, 2021 (86 FR 7037, January 20, 2021). The 2020 CAA Section 608 Rule was one of the actions subject to review. In light of this review and the Agency's consideration of subsection (h) of the AIM Act, EPA has developed this rulemaking, which, among other things, involves evaluating the application of leak repair requirements to appliances using HFCs and substitute refrigerants under subsection (h). Because this action is rooted in EPA's authority under the AIM Act, this rulemaking does not reopen or otherwise address the question of the authority for such requirements under the CAA. Similarly, EPA is not reopening or revisiting any of the regulations under CAA section 608 in this rulemaking.

2. Motor Vehicle Air Conditioning Servicing Program (CAA section 609)

CAA section 609 directs EPA to issue regulations establishing standards and requirements for the servicing of MVACs. For purposes of the regulations implementing CAA section 609, "motor vehicle air conditioners"[41] is defined at 40 CFR 82.32(d) as mechanical vapor compression refrigeration equipment used to cool the driver's or passenger's compartment of any motor vehicle. This definition further states that it is not intended to encompass certain hermetically sealed refrigeration systems used on motor vehicles for refrigerated cargo and the

[41] A related definition for "MVAC-like appliance" is found at 40 CFR 82.152: MVAC-like appliance means a mechanical vapor compression, open-drive compressor appliance with a full charge of 20 pounds or less of refrigerant used to cool the driver's or passenger's compartment of off-road vehicles or equipment. This includes, but is not limited to, the air-conditioning equipment found on agricultural or construction vehicles. This definition is not intended to cover appliances using R-22 refrigerant.

air conditioning systems on passenger buses. For purposes of the section CAA section 609 regulations, "motor vehicle" is defined at 40 CFR 82.32(c) as any vehicle which is self-propelled and designed for transporting persons or property on a street or highway, including but not limited to passenger cars, light-duty vehicles, and heavy-duty vehicles. This definition further provides that it does not include a vehicle where final assembly of the vehicle has not been completed by the original equipment manufacturer (OEM).

Under CAA section 609 and regulations that implement it, no person repairing or servicing motor vehicles for consideration (*e.g.*, payment or bartering) may perform any service on an MVAC that involves the refrigerant[42] without properly using approved refrigerant recovery or recovery and recycling equipment, and no such person may perform such service for consideration unless such person has been properly trained and certified. CAA section 609 also contains restrictions on the sale or distribution, or offer for sale or distribution, of class I and class II substances suitable for use as a refrigerant in MVACs in containers of less than 20 pounds, except to a person performing service for consideration on MVAC systems.

Regulations issued under CAA section 609, codified at 40 CFR part 82, subpart B, include, among other things, prohibited and required practices for persons repairing and servicing MVACs for consideration (40 CFR 82.34); requirements for refrigerant handling equipment (40 CFR 82.36); approval processes for independent standards testing organizations (40 CFR 82.38); requirements for certifications that any person servicing or repairing MVACs for consideration must submit to EPA; and related recordkeeping requirements (40 CFR 82.42).

[42] Section 609(b)(1) defines the term "refrigerant," "[a]s used in this section", to mean "any class I or class II substance used in a motor vehicle air conditioner. Effective 5 years after November 15, 1990, the term 'refrigerant' shall also include any substitute substance." EPA's implementing regulations include a parallel definition of this term at 40 CFR 82.32(f).

Appendices A through F at 40 CFR part 82, subpart B, provide minimum operating requirements for equipment used for the recovery, recycling and/or recharging of refrigerant used in MVACs.

In 1992, EPA published a rule (57 FR 31242, July 14, 1992) under CAA section 609 establishing standards and requirements for servicing of MVACs and restricting the sale of small containers of ODS. The regulations, which appear in 40 CFR part 82, subpart B, require persons who repair or service MVACs for consideration to be certified in refrigerant recovery and recycling and to properly use approved equipment when performing service involving the refrigerant. Consistent with the definition in CAA section 609(b)(1), "refrigerant" is defined in subpart B as any class I or class II substance used in MVACs, and to include any substitute substance effective November 15, 1995. The 1992 CAA section 609 Rule also defined approved refrigerant recycling equipment as equipment certified by the Administrator or an approved organization as meeting either one of the standards in 40 CFR 82.36. Such equipment extracts and recycles refrigerant or extracts but does not recycle refrigerant, allowing that refrigerant to be subsequently recycled on-site or to be sent off-site for reclamation.[43] EPA based the regulatory equipment standards in subpart B on those developed by the Society of Automotive Engineers (SAE). They cover service procedures for dichlorodifluoromethane (CFC-12 or R-12) recover/recycle equipment (SAE J1989, issued in October 1989); test procedures to evaluate R-12 recover/recycle equipment (SAE J1990, issued in October 1989 and revised in 1991); and a purity standard for recycled R-12 refrigerant (SAE J1991, issued in October 1989). Only equipment certified to meet the standards set forth in appendix A at 40 CFR part 82, subpart B,

[43] Equipment that extracts and recycles refrigerant is referred to as recover/recycle equipment. Equipment that extracts but does not recycle refrigerant is referred to as equipment that recovers but does not recycle refrigerant, or as recover-only equipment.

or that meets the criteria for substantially identical equipment, was approved under CAA section 609 for use in the servicing of MVACs at that time.

EPA issued another rule under CAA section 609 in 1997 (62 FR 68026, December 30, 1997) in response to the increasing use of substitute refrigerants, particularly 1,1,1,2-tetrafluoroethane (HFC-134a or R-134a). The 1997 CAA Section 609 Rule established standards and requirements for the servicing of MVACs that use any refrigerant other than R-12. The rule also stated that refrigerant (whether R-12 or a substitute) recovered from motor vehicles at motor vehicle disposal facilities may be re-used in the MVAC service sector only if it has been properly recovered and recycled by persons who are either employees, owners, or operators of the facilities, or technicians certified under CAA section 609, using approved equipment. This differs from the rules established under CAA section 608, in which no person may sell or distribute, or offer for sale or distribution, used refrigerant (including both ODS and non-exempt substitutes such as HFCs) unless it has first been reclaimed by a certified reclaimer (40 CFR 82.154(d)). The 1997 CAA Section 609 Rule also established conditions under which owners and operators of motor vehicle disposal facilities may sell refrigerant recovered from such vehicles to technicians certified under CAA section 609.

3. Significant New Alternatives Policy Program (CAA section 612)

EPA identifies and evaluates substitutes for ODS in certain industrial sectors, including RACHP, aerosols, and foams. To a very large extent, HFCs are used in the same sectors and subsectors as where ODS historically have been used. Under SNAP, EPA evaluates acceptability of substitutes for ODS based primarily on the potential human health and environmental risks, relative to other substances used for the same purpose. In so doing, EPA assesses atmospheric effects such as ozone depletion potential (ODP) and GWP, exposure assessments, toxicity data, flammability, and other environmental impacts. This assessment could take a wide range of forms, such as a theoretical evaluation of the properties of the substitute, a computer simulation of the substitute's performance in the sector or subsector, lab-scale (table-top) evaluations of the substitute, or equipment tests under various conditions.

IV. How is EPA regulating the management of HFCs and their substitutes?

As described in the following sections, EPA is establishing an ER&R program for the management of HFCs under subsection (h) of the AIM Act that includes requirements regarding several topics, including leak repair requirements for certain refrigerant-containing appliances and installation and use of ALD systems for certain equipment; requirements for the use of reclaimed HFCs for the servicing and/or repair of certain refrigerant-containing equipment; requirements for the servicing, repair, disposal, or installation of fire suppression equipment that contains HFCs, with the purpose of minimizing the release of HFCs from that equipment, including requirements for the use of recycled HFCs for the initial charge and servicing and/or repair of fire suppression equipment, as well as requirements related to technician training in the fire suppression sector; and recovery of HFCs from disposable cylinders before discarding. As discussed in greater detail in section X of this preamble, EPA intends for the regulatory provisions established under subsection (h) of the AIM Act in this final action to be able to stand independently from one another and has designed them accordingly. For example, the leak repair requirements for refrigerant-containing appliances are designed to operate independently from the requirements for servicing, repair, disposal, or installation of fire suppression equipment.

A. What definitions is EPA implementing under subsection (h)?

EPA has operated a refrigerant management program for decades under the CAA. More recently, EPA established regulatory programs related to the HFC phasedown and the technology transitions provisions under the AIM Act. Rules implementing those CAA and AIM Act programs have included defined terms, which EPA was mindful of when proposing and finalizing definitions for the ER&R program under subsection (h) of the AIM Act.

The Allocation Framework Rule (86 FR 55116, October 5, 2021) established regulatory definitions at 40 CFR part 84, subpart A to implement the framework for phasing down HFCs under the AIM Act, with certain revisions to the definitions section at 40 CFR 84.3 (see 88 FR 46836, July 20, 2023).[44] Subsequently, the 2023 Technology Transitions Rule (88 FR 73098, October 24, 2023) established additional regulatory definitions in 40 CFR part 84, subpart B, at 40 CFR 84.52 to implement subsection (i) of the AIM Act. To maintain consistency, except as otherwise explained in this rule, EPA generally intends to use terms in this rulemaking, and in the new subpart C established by this rule, consistent with their definitions in subparts A and B, but there may be exceptions, such as where one term has different definitions under different subparts.-The definitions under subpart A had already been finalized when this rule was proposed. Accordingly, consistent with the proposal, for terms not defined in subpart C but that are defined in subpart A (40 CFR 84.3) those definitions apply. As noted previously, EPA also considered the definitions in subpart B (40 CFR 84.52) in establishing the definitions and regulation in subpart C but is not incorporating those definitions into subpart C, in part to avoid potential confusion if the same term were defined differently in subparts A and B, but not defined in subpart B. EPA is also establishing definitions for terms that are applicable only under

[44] The revisions in 40 CFR 84.3 are described in EPA's Allowance Allocation Methodology for 2024 and Later Years rule, which was published on July 20, 2023 (88 FR 46836). That rulemaking focuses on the second phase of the HFC phasedown and, among other things, establishes the allocation methodology for the "general pool" of HFC production and consumption allowances for 2024 through 2028. Available at: *https://www.federalregister.gov/documents/2023/07/20/2023-14312/phasedown-of-hydrofluorocarbons-allowance-allocation-methodology-for-2024-and-later-years.*

40 CFR part 84, subpart C, and do not have counterparts in the definitions under 40 CFR part 84, subparts A or B.

Many of the terms and definitions considered in this action are similar to those used to implement programs under CAA sections 608 and 609, with only limited changes as needed to conform with the AIM Act or this action. EPA considered these previously defined terms, from 40 CFR 82.152 and 40 CFR 82.32, where they are used in the same or substantially similar manner. The regulated community for these regulations under subsection (h) and those under CAA sections 608 and 609 overlap; therefore, maintaining the same or similar definitions, where consistent with AIM Act requirements and the purposes of this action, facilitates implementation by those who have been using and are familiar with these terms. Because EPA's authority under the AIM Act extends beyond the sectors covered by 40 CFR part 82, subpart F, where it is necessary for clarity, EPA is specifying where these definitions specifically apply to the terms as they refer to refrigerant-containing appliances or as they apply to fire suppression.

1. Terms that did not generate comment and that EPA is finalizing as proposed

Many proposed definitions did not garner specific comment. For the reasons discussed in the proposed rule, EPA is finalizing the following terms as proposed, notwithstanding minor grammatical changes that do not alter their meaning (ex: changing a word's tense):

Certified technician means a technician that has been certified per the provisions at 40 CFR 82.161.

Component, as it relates to a refrigerant-containing appliance, means a part of the refrigerant circuit within an appliance including, but not limited to, compressors, condensers, evaporators, receivers, and all of its connections and subassemblies.

Custom-built means that the industrial process refrigeration equipment or any of its components cannot be purchased and/or installed without being uniquely designed, fabricated, and/or assembled to satisfy a specific set of industrial process conditions.

Fire suppression technician means any person who in the course of servicing, repair, disposal, or installation of fire suppression equipment could be reasonably expected to violate the integrity of the fire suppression equipment and therefore release fire suppressants into the environment.

Follow-up verification test, as it relates to a refrigerant-containing appliance, means those tests that involve checking the repairs to an appliance after a successful initial verification test and after the appliance has returned to normal operating characteristics and conditions to verify that the repairs were successful. Potential methods for follow-up verification tests include, but are not limited to, the use of soap bubbles as appropriate, electronic or ultrasonic leak detectors, pressure or vacuum tests, fluorescent dye and black light, infrared or near infrared tests, and handheld gas detection devices.

Full charge, as it relates to a refrigerant-containing appliance, means the amount of refrigerant required for normal operating characteristics and conditions of the appliance as determined by using one or a combination of the following four methods:

(1) Use of the equipment manufacturer's determination of the full charge;

(2) Use of appropriate calculations based on component sizes, density of refrigerant, volume of piping, and other relevant considerations;

(3) Use of actual measurements of the amount of refrigerant added to or evacuated from the appliance, including for seasonal variances; and/or

(4) Use of an established range based on the best available data regarding the normal operating characteristics and conditions for the appliance, where the midpoint of the range will serve as the full charge.

Initial verification test, as it relates to a refrigerant-containing appliance, means those leak tests that are conducted after the repair is finished to verify that a leak or leaks have been repaired before refrigerant is added back to the appliance.

Leak inspection, as it relates to a refrigerant-containing appliance, means the examination of an appliance to detect and determine the location of refrigerant leaks. Potential methods include, but are not limited to, ultrasonic tests, gas-imaging cameras, bubble tests as appropriate, or the use of a leak detection device operated and maintained according to manufacturer guidelines. Methods that determine whether the appliance is leaking refrigerant but not the location of a leak, such as standing pressure/vacuum decay tests, sight glass checks, viewing receiver levels, pressure checks, and charging charts, must be used in conjunction with methods that can determine the location of a leak.

Leak rate, as it relates to a refrigerant-containing appliance, means the rate at which an appliance is losing refrigerant, measured between refrigerant charges. The leak rate is expressed in terms of the percentage of the appliance's full charge that would be lost over a 12-month period if the current rate of loss were to continue over that period. The rate must be calculated using one of the following methods. The same method must be used for all appliances subject to the leak repair requirements located at an operating facility.

(1) Annualizing Method.

(i) Step 1. Take the number of pounds of refrigerant added to the appliance to return it to a full charge, whether in one addition or in multiple additions related to same leak, and divide it by the number of pounds of refrigerant the appliance normally contains at full charge;

(ii) Step 2. Take the shorter of the number of days that have passed since the last day refrigerant was added or 365 days and divide that number by 365 days;

(iii) Step 3. Take the number calculated in Step 1 and divide it by the number calculated in Step 2; and

(iv) Step 4. Multiply the number calculated in Step 3 by 100 to calculate a percentage. This method is summarized in the following formula:

$$\text{Leak rate (\% per year)} = \frac{\text{pounds of refrigerant added}}{\text{pounds of refrigerant in full charge}} \times \frac{365\ \textit{days/year}}{\textit{shorter}\text{ of: \# days since refrigerant last added or 365 days}} \times 100\%$$

(2) Rolling Average Method.

(i) Step 1. Take the sum of the pounds of refrigerant added to the appliance over the previous 365-day period (or over the period that has passed since the last successful follow-up verification test showing all identified leaks in the appliance were repaired, if that period is less than one year);

(ii) Step 2. Divide the result of Step 1 by the pounds of refrigerant the appliance normally contains at full charge; and

(iii) Step 3. Multiply the result of Step 2 by 100 to obtain a percentage. This method is summarized in the following formula:

$$\text{Leak rate (\% per year)} = \frac{\begin{array}{c}\text{pounds of refrigerant added over past 365 days} \\ \text{(or since the last successful follow-up verification test showing all identified} \\ \text{leaks in the appliance were repaired, if that period is less than one year)}\end{array}}{\text{pounds of refrigerant in full charge}} \times 100\%$$

EPA further notes that, as discussed in section IV.C.3 of this preamble, owner or operators may preemptively repair leaks prior to adding refrigerant and calculating the leak rate for a refrigerant-containing appliance. After the completion of preemptive repair, an owner or operator must calculate the leak rate to see if the refrigerant-containing appliance was leaking above the applicable leak rate threshold and complete the full suite of leak repair requirements as described in section IV.C.3 (*e.g.,* verification tests, leak inspections, etc.) if the appliance was leaking above the applicable threshold. If the refrigerant-containing appliance was found to be leaking below the applicable leak rate threshold then no further action is necessary after the completion of the preemptive repair. Alternatively, an owner/operators may use the amount of refrigerant lost in lieu of the amount of refrigerant added to calculate the leak rate prior to adding refrigerant if they have a valid method of determining the amount of refrigerant lost (*e.g.*, evacuating the appliance and comparing the amount of refrigerant evacuated to the full charge).

Mothball, as it relates to a refrigerant-containing appliance, means to evacuate refrigerant from an appliance, or the affected isolated section or component of an appliance, to at least atmospheric pressure, and to temporarily shut down that appliance.

Motor vehicle, as used in this subpart, means any vehicle which is self-propelled and designed for transporting persons or property on a street or highway, including but not limited to passenger cars, light-duty vehicles, and heavy-duty vehicles. This definition does not include a vehicle where final assembly of the vehicle has not been completed by the original equipment manufacturer.

Motor vehicle air conditioner (MVAC), means mechanical vapor compression refrigerant-containing appliances used to cool the driver's or passenger's compartment of any motor vehicle. This definition is intended to have the same meaning as in 40 CFR 82.32.

Normal operating characteristics and conditions, as it relates to a refrigerant-containing appliance, means appliance operating temperatures, pressures, fluid flows, speeds, and other characteristics, including full charge of the appliance, that would be expected for a given process load and ambient condition during normal operation. Normal operating characteristics and conditions are marked by the absence of atypical conditions affecting the operation of the appliance.

Owner or operator, means any person who owns, leases, operates, or controls any equipment, or who controls or supervises any practice, process, or activity that is subject to any requirement pursuant to this subpart.

Recycling, when referring to fire suppression or fire suppressants, means the testing and/or reprocessing of regulated substances used in the fire suppression sector to certain purity standards.

Refrigerant circuit, as it relates to a refrigerant-containing appliance, means the parts of an appliance that are normally connected to each other (or are separated only by internal valves) and are designed to contain refrigerant.

Reprocess, means using procedures such as filtering, drying, distillation, and other chemical procedures to remove impurities from a regulated substance or a substitute for a regulated substance.

Retire, as it relates to a refrigerant-containing appliance, means the removal of the refrigerant and the disassembly or impairment of the refrigerant circuit such that the appliance as a whole is rendered unusable by any person in the future.

Seasonal variance, as it relates to a refrigerant-containing appliance, means the removal of refrigerant from an appliance due to a change in ambient conditions caused by a change in season, followed by the subsequent addition of an amount that is less than or equal to the amount of refrigerant removed in the prior change in season, where both the removal and addition of refrigerant occurs within one consecutive 12-month period.

Stationary refrigerant-containing equipment means refrigerant-containing equipment, as defined in this subpart, that is not a motor vehicle air conditioner or MVAC-like appliance, as defined in this subpart.

Technician, as it relates to any person who works with refrigerant-containing appliances, means any person who in the course of servicing, repair, or installation of a refrigerant-containing appliance (except MVACs) could be reasonably expected to violate the integrity of the refrigerant circuit and therefore release refrigerants into the environment. Technician also means any person who, in the course of disposal of a refrigerant-containing appliance (except small appliances as defined in 40 CFR 82.152, MVACs, and MVAC-like appliances), could be reasonably expected to violate the integrity of the refrigerant circuit and therefore release refrigerants from the appliance into the environment. Activities reasonably expected to violate the integrity of the refrigerant circuit include but are not limited to: Attaching or detaching hoses and gauges to and from the appliance; adding or removing refrigerant; adding or removing components; and cutting the refrigerant line. Activities such as painting the appliance, rewiring an external electrical circuit, replacing insulation on a length of pipe, or tightening nuts and bolts are not reasonably expected to violate the integrity of the refrigerant circuit. Activities conducted on refrigerant-containing appliances that have been properly evacuated pursuant to 40 CFR 82.156 are not reasonably expected to release refrigerants unless the activity includes adding refrigerant to the appliance. Technicians include but are not limited to installers, contractor employees, in-house service personnel, and owners and/or operators of refrigerant-containing appliances.

EPA further notes that this definition deviates slightly from the definition of "technician" at 40 CFR 82.152 to conform with the AIM Act grant of authority. EPA is also defining "certified technician" to make it clear that EPA is referring to persons certified per 40 CFR 82.161 for the purposes of these regulations. When specifically referring to technicians certified under 40 CFR part 82, subpart B, the term "609-certified technician" is used.

2. Terms that received comment or that EPA is modifying

This section discusses comments received on specific proposed definitions, EPA's responses to those comments, and any changes made to the final definitions.

Comfort cooling. EPA proposed to define this term as "the refrigerant-containing appliances used for air conditioning to provide cooling in order to control heat and/or humidity in occupied facilities including but not limited to residential, office, and commercial buildings. Comfort cooling appliances include but are not limited to chillers, commercial split systems, and packaged roof-top units."

As described below, after considering public comment on this definition, EPA is modifying its definition of "comfort cooling" to include dual-function heat pumps as an additional example of the term.

Comment: One commenter requested that EPA's definition of "comfort cooling" include single-function (heat only) and dual-function (heating and cooling) heat pump appliances.

Response: EPA agrees that dual-function heat pumps are included within the definition of "comfort cooling" because those appliances provide cooling. To provide another relevant example of comfort cooling applications, EPA is adding dual-function heat pumps to the illustrative list of examples in the definition. EPA is not including single-function heat pump applications as an example of an application included in "comfort cooling" because EPA does not view it as fitting within this particular category as the definition is currently drafted. EPA may in the future consider proposing to include single-function heat pump applications under comfort cooling or under a different category of equipment.

Commercial refrigeration. EPA proposed this definition to mean "the refrigerant-containing appliances used in the retail food and cold storage warehouse subsectors. Retail food appliances include the refrigeration equipment found in supermarkets, convenience stores, restaurants and other food service establishments. Cold storage includes the refrigeration equipment used to store meat, produce, dairy products, and other perishable goods."

EPA is finalizing two modifications to the proposed definition of "commercial refrigeration." Both modifications involved replacing the term "refrigeration equipment" in sentences two and three of the proposed definition of the term to "refrigeration-containing equipment" in the finalized term. These changes were made because "refrigeration equipment" is not a defined term under this subpart, but "refrigeration-containing equipment" is. EPA did not receive comment on the definition of "commercial refrigeration."

Disposal. EPA proposed to define this term, as it relates to a refrigerant-containing appliance, as "the process leading to and including:

(1) The discharge, deposit, dumping or placing of any discarded refrigerant-containing appliance into or on any land or water;

(2) The disassembly of any refrigerant-containing appliance for discharge, deposit, dumping or placing of its discarded component parts into or on any land or water;

(3) The vandalism of any refrigerant-containing appliance such that the refrigerant is released into the environment or would be released into the environment if it had not been recovered prior to the destructive activity;

(4) The disassembly of any refrigerant-containing appliance for reuse of its component parts; or

(5) The recycling of any refrigerant-containing appliance for scrap."

EPA's proposed definition of "disposal" applied to "refrigerant-containing appliances." This was done to maintain consistency with the definition of "disposal" in 40 CFR 82.161 which applies to "appliances." EPA is finalizing a definition of disposal with two parts, with the first part relating to "refrigerant-containing equipment" and the second part relating to "fire suppression equipment." Furthermore, in the first part of the final definition EPA is using the term "refrigerant-containing equipment" instead of "refrigerant-containing appliance" to more fully align with the regulatory definition with how the term disposal is used under subsection (h)(1) of the AIM Act, which states "the Administrator shall promulgate regulations to control, where appropriate, any practice process or activity regarding servicing, repair, disposal, or installation of *equipment* (emphasis added)." "Refrigerant-containing equipment" is broader than "refrigerant-containing appliance" and includes everything covered under the definition of "refrigerant-containing appliance" (*e.g.*, any air conditioner, MVAC, refrigerator, chiller, or freezer) while also including refrigerant-containing components. However, the regulatory requirements related to disposal of refrigerant-containing equipment established in this final action at 84.106 apply to refrigerant-containing appliances (rather than refrigerant-containing equipment), and this change in the definition is not intended to broaden the scope of these requirements.

EPA added a second part to the final definition of disposal to distinguish disposal of fire suppression equipment. Since this final rule regulates the disposal of fire suppression equipment, which may differ from the disposal of refrigerant-containing equipment, the Agency is specifying how the term "disposal" relates to fire suppression equipment in this subpart, for greater clarity of the regulatory provisions. This final definition of disposal is analogous to the definition of "disposal of halon-containing equipment" in the halon emissions reduction requirements at 40 CFR part 82, subpart H, which EPA referenced in the proposal, describing its intent to propose requirements similar to those in subpart H. The final definition parallels the definition of disposal at 40 CFR 82.260, with the words "fire suppression equipment" replacing the term "halon-containing equipment" to maintain consistency with regulations for the disposal of halon-containing equipment, including halon-containing equipment used in fire suppression applications. The revised definition can be read in full below:

Disposal, as it relates to refrigerant-containing equipment, means the process leading to and including:

(1) The discharge, deposit, dumping, or placing of any discarded refrigerant-containing equipment into or on any land or water;

(2) The disassembly of any refrigerant-containing equipment for discharge, deposit, dumping, or placing of its discarded component parts into or on any land or water;

(3) The vandalism of any refrigerant-containing equipment such that the refrigerant is released into the environment or would be released into the environment if it had not been recovered prior to the destructive activity;

(4) The disassembly of any refrigerant-containing equipment for reuse of its component parts; or

(5) The recycling of any refrigerant-containing equipment for scrap.

Disposal, as it relates to fire suppression equipment, means the process leading to and including:

(1) The discharge, deposit, dumping, or placing of any fire suppression equipment into or on any land or water;

(2) The disassembly of any fire suppression equipment for discharge, deposit, dumping, or placing of its discarded component parts into or on any land or water; or

(3) The disassembly of any fire suppression equipment for reuse of its component parts.

Comment: One commenter asserted that the proposed definition of disposal (which as originally proposed was specific to a “refrigerant-containing appliance”) is inconsistent with the principles of safe disposal under 40 CFR 82.155 and with the definition of disposal under RCRA. The commenter argued that parts 4 and 5 of the definition incorrectly conflate two different processes (disassembly and recycling). The commenter further stated that since there are “safe disposal” regulations at 40 CFR 82.155, it is counterproductive to have a definition of disposal that includes principles of recycling, because disposal and recycling are entirely different processes. The commenter also argued that the definition of disposal under 40 CFR 82.155 and 40 CFR 84.102 is incompatible with RCRA’s definition of disposal under 40 CFR 260.10, which does not include practices of disassembly or recycling. The commenter requested that EPA align the proposed definition with those in 40 CFR 82 subparts B and F to minimize complications and contradictions between these AIM Act subsection (h) regulations and CAA title VI regulations.

Response: EPA is finalizing a definition of "disposal," as it relates to refrigerant-containing equipment, that parallels the definition in 40 CFR 82.152. To the extent the commenter is suggesting that the proposed definition of disposal is inconsistent with the requirements in 82.155, EPA disagrees. Rather, the definition in 40 CFR 84.102 is analogous to the definition of disposal in 40 CFR part 82, subpart F at 40 CFR 82.152, the safe disposal provisions also found subpart F at 40 CFR 82.155, as 82.155 does not contain a separate definition of "disposal." To the extent this comment relates to the requirements of or suggestions to change 82.155 or any other regulations under CAA title VI, it is outside the scope of this rulemaking and requires no further response.

EPA disagrees that parts 4 and 5 of the proposed definition are incorrectly conflated. Recycling and disassembly for reuse are distinct processes under these regulations, but they are both end-of-life practices for refrigerant-containing equipment. The definition is intended to include a range of end-of-life practices to ensure the requirements cover the range of relevant activities. The commenter has not provided sufficient rationale for why the relevant requirements under this subpart should not apply to both disassembly and recycling. Accordingly, the Agency is retaining both 4 and 5 in the definition as it relates to refrigerant-containing equipment.

The definitions of recycle and disposal under RCRA are outside the scope of this rulemaking under subsection (h) of the AIM Act and this action to establish the definitions that will apply for the regulations implementing that provision. For information on public comments on the proposed RCRA alternative standards, and EPA's responses, please see *RCRA Alternative*

Standards for Ignitable Spent Refrigerants: Response to Comments Document, available in the docket.

Equipment. EPA proposed this definition to mean "any device that contains, uses, detects or is otherwise connected or associated with a regulated substance or substitute for a regulated substance, including any refrigerant-containing appliance, component, or system."

EPA modified its definition of equipment to specify that fire suppression equipment is also included under the definition of equipment. This revision is intended to clarify the definition by providing another illustrative example of equipment that is included in the definition. EPA does not view this list of examples as being exhaustive, however as it would be unnecessarily cumbersome to list all of the equipment that is included in the regulatory definition. For example, while not expressly listed in the definition. EPA also understands this definition to include direct and indirect ALD systems, including point detection systems, are a subset of equipment because ALD systems are devices that detect regulated substances or substitutes for regulated substances.

Fire suppression equipment. EPA proposed this term to mean "any device that is connected to or associated with a regulated substance or substitute for a regulated substance, including blends and mixtures, consisting in part or whole of a regulated substance or a substitute for a regulated substance, and that is used for fire suppression purposes. This term includes any such equipment, component, or system. This term does not include mission-critical military end uses and military systems used in deployable and expeditionary situations. This term also does not include space vehicles as defined in 40 CFR 84.3."

EPA is modifying the final definition by replacing the phrase "mission-critical military end uses and systems" with "military equipment" to provide greater clarity on situations in which military equipment are exempt from certain provisions of the rule. As discussed later in this section, EPA is amending the definition of refrigerant-containing equipment in the same manner.

EPA intended the proposed definition to clarify that certain military equipment would not be subject to regulatory requirements in certain situations. The reference to "mission-critical military end uses and systems" was intended to be analogous to the use of the similar term "mission-critical military end uses" in 40 CFR 84.13(a). After further reflection and consideration of the comments submitted, the Agency has concluded that it would be clearer to separately address the exemption for mission-critical military end uses, and that this approach would better align with how these end-uses are treated under other provisions of the AIM Act. Accordingly, as noted in section I.B, EPA is also establishing an exemption from the ER&R regulations for mission-critical military end uses, as listed at 40 CFR 84.13(a), for a year or years for which the application receives an application-specific allowance as defined at 40 CFR 84.3. This approach mirrors the approach in regulations established under the 2023 Technology Transitions Rules at 84.56(a)(2) and better aligns with the regulations under 84.13. Given the addition of this exemption to the regulations finalized in this rule (see 84.114(b)), there is no need to exclude mission-critical military end uses from the definition of fire suppression equipment. With respect to military systems used in deployable and expeditionary situations, as stated in the proposal, there are situations in which the unique design and use of this equipment makes it impossible to recover fire suppression agents during the service, repair, disposal, or installation of such equipment. Because this rule does not define "end uses" or "systems," EPA is using the broader term "equipment" to improve understanding and clarify its intent that no military equipment used in deployable and expeditionary situations is subject to the regulations for fire suppression equipment in this rule.

Comment: One commenter requested that EPA exclude individual fire extinguishers from the definition of "fire suppression equipment." Another commenter supported exempting mission-critical military end uses from certain requirements of the rule. This commenter suggested that EPA could improve the clarity of the rule by stating that specific requirements (*e.g.*, leak repair, ALD systems) do not apply to mission-critical end uses and systems, rather than embedding the exemption in the definitions of "refrigerant-containing equipment" and "fire suppression equipment." The commenter further stated that affirmatively stating that certain requirements do not apply to mission-critical military end uses would make this rule consistent with the Allocation Framework Rule and would help improve compliance with this final rule.

Response: EPA disagrees with the commenter's request to exclude individual fire extinguishers from the definition of fire suppression equipment. EPA has a long history under the CAA title VI regulations of considering fire suppression as both streaming (*e.g.*, fire extinguishers) and total flooding applications. The commenter did not provide sufficient rationale for changing that approach in this rule and EPA is concerned that doing so would limit the ability of this rule to achieve its intended purpose with respect to minimizing releases from fire suppression equipment.

In response to the comment suggesting that EPA exempt mission-critical military end uses from certain requirements of the rule separate from the definition, as described above, EPA notes, that it has created a separate exemption in these regulations for mission-critical military end uses, as listed at 40 CFR 84.13(a), for a year or years for which that application receives an application-specific allowance as defined at 40 CFR 84.3. As explained above, EPA is taking this approach, rather than listing the exemption in each specific requirement, as that approach better aligns with the approach under other AIM Act rules, which should ease understanding of the exemption and facilitate implementation and compliance.

Industrial process refrigeration. EPA is finalizing this term as proposed to mean "complex, customized, refrigerant-containing appliances that are directly linked to the processes used in, for example, the chemical, pharmaceutical, petrochemical, and manufacturing industries. This sector also includes industrial ice machines, appliances used directly in the generation of electricity, and ice rinks. Where one appliance is used for both industrial process refrigeration and other applications, it will be considered industrial process refrigeration equipment if 50 percent or more of its operating capacity is used for industrial process refrigeration."

Comment: One commenter stated that in the Technology Transitions program, EPA determined appliances that cool data centers, information technology equipment facilities (ITEFs), computer room cooling equipment, communications rooms, and appliances associated with cooling other spaces dedicated to maintaining the operating temperatures of electronic devices were not IPR or comfort cooling. The commenter further stated that under 40 CFR part 82, subpart F these refrigerant-containing devices are comfort cooling. The commenter requested that EPA specify whether these appliances are comfort cooling or IPR. The commenter stated that all industrial facilities have data centers or computer rooms and need to understand how to properly sort their appliances because this impacts leak rate repair triggers and appliance repair time.

Response: The commenter is correct that the definition of "comfort cooling" in 40 CFR part 82, subpart F. codified at 40 CFR 82.152 includes appliances that cool data centers, ITEF, computer rooms, communications rooms, and electronic devices. EPA intends for its definition of "industrial process refrigeration" under these regulations to parallel the definition within 40

CFR 82.152 as many of these requirements established for industrial process refrigeration and comfort cooling in this rule are analogous to those that apply under 40 CFR part 82, subpart F and EPA anticipates that using parallel definitions will facilitate understanding of the rule's requirements amongst regulated entities and support compliance for those entities that already have established approaches to complying with similar requirements for similar equipment under subpart F. Accordingly, the appliances that cool data centers, ITEF, computer room cooling equipment, communications rooms, and appliances associated with cooling other spaces dedicated to maintaining the operating temperatures of electronic devices are considered comfort cooling for purposes of the ER&R program established in this rule.

Installation. EPA is finalizing this term as proposed to mean "the process of setting up equipment for use, which may include steps such as completing the refrigerant circuit, including charging equipment with a regulated substance or substitute for a regulated substance, or connecting cylinders containing a regulated substance or a substitute for a regulated substance to a total flooding fire suppression system, such that the equipment can function and is ready for use for its intended purpose."

The definition of "installation" for purposes of the ER&R program is broader than a definition for a similar term used in the Technology Transitions program, which is found in 40 CFR part 84, subpart B. Specifically, the definition for "install" in subpart B refers only to the completion of a field-assembled system's circuit. "Installation" in this rulemaking under subsection (h) includes processes, practices and activities related to installation of equipment that are encompassed in the Technology Transitions program's definitions for both "installation" and "manufacture" at 40 CFR 84.52, as well as other types of installation. EPA is establishing a broader definition under subsection (h) to encompass the full range of practices, processes, or activities that are relevant to the installation of equipment that is regulated under this action, or that may be regulated under a future rule under subsection (h). Included under this definition of installation is the process of setting up of ALD systems for use, because ALD systems are considered equipment under this subpart.

Comment: One commenter argued that the activity of installation is commonly understood to relate to physically placing equipment in a facility or location, not to the initial charging of equipment during manufacture nor the field charging of refrigeration systems during construction. The commenter further maintained that read together, the terms that Congress used in subsection (h)(1) ("servicing, repair, disposal, or installation of equipment") naturally refer to work performed on the equipment, not to the design of the equipment or the choice of which refrigerant is used in the equipment. The commenter argued that if Congress had intended for EPA to have the ability to mandate what type of refrigerant is used in the equipment, it would more naturally have listed installation first in the serialization of activities, because installation is the first activity in the temporal sequence, followed by servicing and repair, and ultimately disposal of the equipment at end of life (EOL).

Another commenter stated that subsection (h)(1) contained limited authority regarding servicing, repair, disposal, and installation of equipment, and that the scope of any EPA regulations to implement subsection (h)(1) must remain within these parameters. The commenter further stated that subsection (h) does not contain any provision concerning the "initial" charging of equipment prior to sale or distribution– nor is there any specific mention in the statute of any subsequent charging of existing equipment. The commenter also stated that "servicing" was not defined in the proposed rule and that EPA has not clarified what constitutes "servicing" of existing equipment, although, charging of existing equipment could constitute "servicing."

Response: EPA disagrees with commenters that the term "installation" as used in context in subsection (h)(1) of the AIM Act does not include the addition of refrigerant to an appliance. Read in context, in relevant part, subsection (h) directs EPA to establish regulations to "control, where appropriate, any practice, process, or activity regarding the … installation of equipment … that involves" an HFC or a substitute for an HFC or the reclaiming of an HFC or a substitute for an HFC used as a refrigerant. The better reading of this provision is that the regulatory authority extends to a range of practices, processes, or activities regarding installation, and that this may include activities both before and after placement on the site. An important part of installation of equipment is to prepare it for use, and adding refrigerant to refrigerant-containing equipment is a critical step in preparing the equipment for use, as the equipment cannot serve its intended use until it has been charged. Based on this interpretation of the statutory text, EPA is including the charging of equipment in the definition of "installation" in these regulations implementing subsection (h)(1). EPA agrees with the commenters to the extent that they assert that the terms that Congress used in subsection (h)(1) ("servicing, repair, disposal, or installation of equipment") include work performed on the equipment, but for the reasons explained earlier in this response, EPA disagrees that the regulatory authority under subsection (h)(1) is limited to work performed directly on equipment. EPA disagrees with one commenter's suggested definition of "installation" as it would end at mere placement of the equipment on site and exclude work performed to allow the system to function. Given that the text of subsection (h)(1) of the AIM Act expressly provides that the regulations established are to address practices, processes, or activities regarding the installation of equipment "that involves a regulated substance or a substitute for a regulated substance," EPA concludes it is not appropriate to create a definition that focuses solely on work on the equipment and excludes work that plainly "involves" an HFC or substitute for an HFC, such as charging equipment. Further the Agency does not ascribe the same meaning to the sequencing of the terms as one of the commenters does and the commenter's interpretation does not seem reasonable as it could eliminate many aspects of installation without any indication that Congress intended for the term to be so limited. There could be other reasons that Congress put "installation" at the end of the sequence. For example, Congress may have been aware of mirroring similar provisions in CAA section 608, such as section 608(a)(1) and (2), which convey authority to establish regulations related to the "service, repair, or disposal of appliances and industrial process refrigeration." Congress may have added "installation" at the end of the sequence because it was an addition to the terms that were included in section 608. Accordingly, EPA does not agree that either the interpretation of the term "installation" nor the definition of the term in the implementation of regulations should be as limited as commenters suggest.

EPA disagrees with the comment that EPA define "servicing" in this final rule. EPA did not propose to do so, in part because it expected that the term would be understood by the regulated community without a definition, based in part on its experience with the regulations under CAA section 608, which addresses servicing of appliances without defining the term, and to EPA's knowledge, that lack of a definition has not hindered implementation of those regulations. EPA interprets installation and servicing to have distinct meanings under subsection (h)(1), as each is listed separately. However, EPA understands that adding refrigerant to existing equipment may also be part of servicing that equipment and does not intend for the inclusion of charging equipment in the regulatory definition of installation to suggest that adding refrigerant to equipment would only occur during installation, but simply that it may occur as part of installation. While EPA is not establishing a definition of servicing in this rule, it notes that other examples of servicing may include, but are not limited to, activities that involve the opening of the refrigerant loop, such as charging equipment, replacing component parts, or checking for leaks.

EPA discusses its authority for the requirements finalized in this rule regarding installation and servicing of equipment in greater detail in the relevant sections below.

MVAC-like appliance. EPA proposed this term to mean "a mechanical vapor compression, open-drive compressor refrigerant-containing appliance with a full charge of 20 pounds or less of refrigerant used to cool the driver's or passenger's compartment of off-road vehicles or equipment. This includes, but is not limited to, the air-conditioning equipment found on agricultural or construction vehicles. This definition is intended to have the same meaning as in 40 CFR 82.152."

EPA modified its proposed definition of "MVAC-like appliance" by deleting the first instance of the phrase "or equipment" and changing the second instance of "or equipment" with "or appliances." EPA deleted the first instance of the phrase "or equipment" from the definition because the use of the term "equipment" in this instance does not align with the definition of "equipment" as defined in this rulemaking. This deletion is intended to clarify the intent of the definition, as the use of "equipment" in this context of "off-road vehicles or equipment" could have been confusing because it is not being used in the sense of how the term "equipment" is defined in these regulations. Regarding the second instance of "air conditioning equipment" EPA changed this language to "air conditioning appliances" to better align the types of devices that the definition of the term "MVAC-like appliance" covers under 40 CFR 82.152 with the types of devices covered under this rulemaking. EPA still intends the definition to have the same meaning as in 40 CFR 82.152.

Recover. EPA is finalizing this term as proposed to mean "the process by which a regulated substance, or where applicable, a substitute for a regulated substance, is removed, in any condition, from equipment; and stored in an external container, with or without testing or processing the regulated substance or substitute for a regulated substance."

The term "recover" is defined in the AIM Act at subsection (b)(10) as "the process by which a regulated substance is (A) removed, in any condition, from equipment; and (B) stored in an external container, with or without testing or processing the regulated substance." EPA proposed to extend the regulatory definition in these regulations to include "where applicable, substitutes for regulated substances" to support implementation of subsection (h)(1), which authorizes certain regulations involving substitutes for regulated substitutes. Substitutes for regulated substances are used in the same applications and often the same equipment as the regulated substances that they are being used in place of. Thus, recovering a substitute for a regulated substance would also occur, as appropriate, during the servicing, repair, or disposal of equipment and could be addressed by regulations under subsection (h)(1).

Comment: One commenter stated that the term "recover" to insufficiently defined under the AIM Act and indicated that this could lead to a loophole where virgin HFCs are placed into equipment for only a short amount of time and then labeled as recovered. Another commenter stated that EPA should consider recovered refrigerant as refrigerant "installed in equipment for the purpose of operating the equipment for an extended amount of time."

Response: EPA responds that, as noted above, subsection (b)(10) of the AIM Act defines "recover" as "the process by which a regulated substance is (A) removed, in any condition, from equipment; and (B) stored in an external container, with or without testing or processing the regulated substance." This definition is similar to the same term as defined in 40 CFR 82.152, which defines "recover" to mean "to remove refrigerant in any condition from an appliance and to store it in an external container without necessarily testing or processing it in any way." While charging a regulated substance into a piece of equipment and then recovering it without allowing it to be used for its intended purpose could be a loophole, EPA has not encountered confusion around this term under the CAA regulations at 40 CFR 82.152, and the commenters did not provide sufficient rationale to change this aspect of the statutorily defined term in this regulation.

The Agency however takes note of the scenario the commenter provided as a potential means for circumventing the requirements and views such an approach as inconsistent with the intent of the definition. Moreover, EPA is establishing a definition of "virgin regulated substance" in this rulemaking to make it clear that introduction of a regulated substance to equipment, such as a refrigerant-containing appliance or fire suppression equipment, solely or primarily to convert or attempt to convert its status to a "used" regulated substance and circumvent the intended requirements of this rule is not permissible. A regulated substance that has had no bona fide use in equipment (as described in the definition for "virgin regulated substance") would still be considered a virgin regulated substance.

Refrigerant. EPA proposed this term to mean, for purposes of this subpart, "any substance, including blends and mixtures, consisting in part or whole of a regulated substance or a substitute for a regulated substance that is used for heat transfer purposes, including those that provide a cooling effect."

After considering comments, EPA is modifying the final definition by replacing the phrase "including those that provide a cooling effect" with the phrase "and provides a cooling effect." This change aligns with the definition of "refrigerant" in 40 CFR 82.152 and will maintain a consistent understanding of the term in the ER&R program and in the regulations under section 608 of the CAA.

Comment: One commenter asked whether heat transfer fluids that do not provide a cooling effect are regulated under this rule. The commenter stated that EPA's proposed definition could include heat transfer fluids that do not provide a cooling effect, including fluorinated heat transfer fluids (F-HTFs). The commenter indicated that this was likely not EPA's intention, citing EPA's rulemaking 69 FR at 11946, 11957 (March 12, 2004), which excluded heat transfer fluids that do not provide a cooling effect. The commenter further stated that F-HTFs have never been used as a substitute for ODS, unlike regulated substances that provide a cooling effect. The commenter provided the following alternative definition: "Refrigerant, for purposes of this subpart, means any gaseous substance, including blends and mixtures, consisting in part of or whole of a regulated substance or a substitute for a regulated substance that is used in a heat cycle, and reversibly undergoes a phase change from a gas to a liquid, to provide a cooling effect."

Response: EPA acknowledges the commenter's suggestion for an alternative definition for the term refrigerant and in response agrees with the commenter that F-HTFs that do not circulate through the compressor of a system are not considered refrigerants for the purposes of this rule. EPA has historically treated these fluids separately from refrigerants. However, EPA notes that subsection (h)(1) of the AIM Act is not limited to refrigerants but rather "equipment…that involves a regulated substance, or a substitute for a regulated substance." This rule includes HFCs used as fire suppression agents in fire suppression equipment and in a later rulemaking action could include HFCs used as heat transfer fluids. Furthermore, the commenter's alternative definition only covers vapor compression systems and not alternative types of refrigeration systems such as non-mechanical heat-transfer with a circulating cooler or a thermosiphon, which EPA has included as an end-use under SNAP. For those reasons, rather than adopting the commenters' suggested definition, EPA is modifying the proposed definition as described above to clarify that heat transfer fluids that do not provide a cooling effect are not included in the definition of "refrigerant" established in this rule.

Refrigerant-containing appliance. EPA proposed this term to mean "any device that contains and uses a regulated substance or substitute for a regulated substance as a refrigerant including any air conditioner, motor vehicle air conditioner, refrigerator, chiller, or freezer. For a system with multiple circuits, each independent circuit is considered a separate appliance."

After considering comments, EPA is modifying the final definition by replacing the phrase "a system with multiple circuits" to "equipment with multiple circuits." This edit is intended to increase clarity, as the term "equipment" is defined in this rule and is a broader category that includes "refrigerant-containing appliance." The final definition also adds "included, but is not limited to," to clarify that air conditioners, refrigerators, chillers, and freezers are intended as illustrative examples, but is not an exhaustive list of all possible devices that meet the definition of refrigerant-containing appliances under this subpart. EPA further notes that a refrigerant-containing appliance could be of any size and include residential, commercial, or industrial appliances.

As the term "refrigerant-containing appliance" is not a defined term under the AIM Act, and as the Agency is establishing certain regulatory requirements that apply only to refrigerant-containing appliances in this rule, the regulatory definition is designed to provide clarity as to what types of equipment are subject to those requirements. EPA intends this term to be a subset of the broader category of "refrigerant-containing equipment" which is also defined in this rule as discussed below, and EPA understands that any exclusions from the definition of "refrigerant-containing equipment" would necessarily also apply to refrigerant-containing appliances. EPA notes that this definition differs from the definition of a similar term, "appliance," under CAA section 608. CAA sections 601 and 608 specified that an appliance "is used for household or commercial purposes," and that phrase also appears in the definition of "appliance" in 40 CFR 82.152. The AIM Act has no analogous provision; rather subsection (h) focuses more broadly on "equipment." Accordingly, EPA is not including that phrase in defining "refrigerant-containing appliance" for purposes of implementing subsection (h). Similar to EPA's approach to similar equipment under the application of title VI of the CAA (*e.g.*, under sections CAA sections 608 and 612), EPA is defining a "refrigerant-containing appliance" to consist of an independent circuit. The independent circuit provides the desired cooling effect, typically consisting of a compressor, condenser, evaporator, and metering device in an enclosed refrigerant loop. EPA notes that a given piece refrigerant-containing equipment could contain multiple independent circuits and thus be considered as multiple, separate "refrigerant-containing appliances." For instance, some food retail cases have been made with multiple independent circuits, each one containing the maximum 150-gram charge limit of propane, thus allowing a single case to address a higher refrigeration load.

Comment: One commenter recommended that EPA define each independent closed loop circuit as a separate appliance, citing confusion caused by different usage of the term "appliance" by the industry.

Response: EPA agrees that each independent closed loop circuit is a separate appliance and has clarified the final definition, as described above.

Refrigerant-containing equipment. EPA proposed this term to mean "equipment that contains, uses, or is otherwise connected or associated with a regulated substance or substitute for a regulated substance that is used as a refrigerant. This definition includes refrigerant-containing components, refrigerant-containing appliances, and MVAC-like appliances. This term does not include mission-critical military end uses and systems used in deployable and expeditionary situations. This term also does not include space vehicles as defined in 40 CFR 84.3."

EPA is modifying the final definition by replacing the phrase "mission-critical military end uses and systems" with "military equipment."

As finalized, this definition of "refrigerant-containing equipment" does not include military equipment used in deployable and expeditionary applications, nor does it include space vehicles. These exclusions are based on EPA's understanding that there are situations in which the unique design and use of military equipment used in deployable and expeditionary situations and space vehicles make it impossible to recover refrigerant during the service, repair, disposal, or installation of the equipment. Likewise, requiring adherence to the leak repair requirements and other provisions for refrigerant-containing equipment in this rulemaking in an active military zone of engagement, including military systems used in deployable and expeditionary situations, could lessen the military effectiveness of the equipment. Similarly, the exclusion for space vehicles is based on EPA's understanding that requiring leak repair and other provisions in this rulemaking for such equipment could lessen their effectiveness. EPA notes that an identical exclusion for military equipment and space vehicles was made in the finalized definition of "fire suppression equipment." Further, as noted in section I.B and-explained in greater detail in the discussion of the definition for "fire suppression equipment" above, while EPA replaced the phrase "mission-critical military end uses and systems" with "military equipment" in this definition, this final rule also includes a separate exemption from the ER&R regulations for mission-critical military end uses (as listed at 40 CFR 84.13(a)), for a year or years for which the application receives an application-specific allowance as defined at 40 CFR 84.3.

Comment: One commenter stated that the proposed rule creates confusion by having separate definitions for equipment, refrigerant-containing appliance, and refrigerant-containing equipment. The commenter stated that EPA's definition of "refrigerant-containing appliance" would have been sufficient for all the instances in which "equipment" or "refrigerant-containing equipment" were used, and that EPA should only finalize a definition for "refrigerant-containing appliance," and rename it "refrigerant-containing equipment" to be consistent with subsection (h) of the AIM Act.

Response: EPA disagrees with this comment, as the terms "equipment," "refrigerant-containing equipment," and "refrigerant-containing appliance" are not used interchangeably in the rule. Rather, these three definitions are intended to have distinct meanings. For example, "refrigerant-containing equipment" is a broader category that includes applications that are not covered under "refrigerant-containing appliance." For example, "refrigerant-containing equipment" includes refrigerant-containing components, whereas the definition of "refrigerant-containing appliance" does not. "Equipment" is an even broader category that includes both equipment that does and equipment that does not contain refrigerant. For example, fire suppression equipment is included in the definition of equipment but not the definition of "refrigerant-containing equipment." Different requirements apply to different types of equipment under the regulations established in this *final rule*. Given these distinctions, EPA is retaining all three of these definitions in the final rule.

Repair. EPA is finalizing this term as proposed, for purposes of this subpart and as it relates to a particular leak in a refrigerant-containing appliance, to mean making adjustments or other alterations to that refrigerant-containing appliance that have the effect of stopping leakage of refrigerant from that particular leak.

Comment: One commenter expressed support for EPA's proposed definition of repair and the discussion of the purpose of repair in the preamble of the proposed rule.

Response: After considering comments, EPA is finalizing the definition of "repair" as proposed.

Retrofit. EPA proposed this definition, as it relates to a refrigerant-containing appliance, to mean "to convert an appliance from one refrigerant to another refrigerant. Retrofitting includes the conversion of the appliance to achieve system compatibility with the new refrigerant and may include, but is not limited to, changes in lubricants, gaskets, filters, driers, valves, o-rings, or appliance components. Retrofits required under this subpart shall be done to a refrigerant with a lower-GWP."

EPA is modifying the final definition by removing the last sentence requiring that retrofits be done with a refrigerant with a lower-GWP. The proposed definition was meant to prevent the retrofit of refrigerant-containing appliances to a higher-GWP refrigerant as a compliance option. EPA decided in this final rule to not require the retrofit of an appliance to a lower-GWP refrigerant. The Agency acknowledges that there are situations where retrofitting to a lower-GWP refrigerant may not be feasible, such as when there is an inadequate supply of lower-GWP refrigerant or when technical standards do not allow the retrofit from a non-flammable refrigerant to a flammable refrigerant. Some appliances may have a limited number of lower-GWP alternatives, making it more difficult to retrofit a system to meet leak repair requirements. While the owner of a refrigerant-containing appliance has other ways to meet leak repair requirements, such as sufficiently repairing leaks or retiring the system, EPA does not want to limit the number of compliance options by prohibiting the retrofit of an appliance to a higher-GWP refrigerant. EPA emphasizes that it still encourages the retrofit of systems to lower-GWP refrigerants whenever possible.

Comment: A few commenters were opposed to a requirement that retrofits always be to a refrigerant with a lower-GWP. One commenter stated that requiring retrofits to only lower-GWP refrigerants would produce logistical challenges, create supply constraints, and increase costs. Another commenter stated EPA to avoid discouraging retrofits from refrigerants like R-22, R-404A, and R-507A to lower-GWP alternatives that still exceed the GWP limits in the 2023 Technology Transitions Rule (R-448, R-449, R-427, R-407H, and R-407A for commercial and industrial). The commenter stated that transitioning from R-404A to lower-GWP options will benefit the HFC phasedown. One commenter supported EPA retaining its definition to require retrofits to low-GWP refrigerants and stated that requiring retrofit plans to use lower GWP refrigerants is consistent with the phasedown and the intent of the AIM Act and may help mitigate ongoing leakage that may occur after the retrofit is completed.

Response: EPA acknowledges these comments both supporting and opposing the proposed definition. After consideration of these comments, for the reasons discussed above in describing the modifications to the proposed definition in the final definition, EPA is not requiring that retrofits use lower GWP refrigerants in this final rule, As noted above, while not requiring it, EPA encourages the retrofit of refrigerant-containing appliances to lower-GWP refrigerants whenever possible. With respect to the comments related to the restrictions established in the 2023 Technology Transitions Rule, EPA notes that the rule did not address retrofits and applies only to new systems (including for refrigerant-containing appliances). Regarding the intent of the Act, the commenter did not provide any rationale to support the position that the intent of the AIM Act was to require retrofits to use lower-GWP refrigerants. EPA further notes that the AIM Act does not expressly address whether a lower-GWP refrigerant should be used for retrofits, and for the reasons explained above, EPA has decided not to establish that requirement in this rule.

Substitute for a regulated substance. EPA is finalizing this definition as proposed to mean "a substance that can be used in equipment in the same or similar applications as a regulated substance, to serve the same or a similar purpose, including but not limited to a substance used as a refrigerant in a refrigerant-containing appliance or as a fire suppressant in fire suppression equipment, provided that the substance is not a regulated substance or an ozone-depleting substance."

Subsection (h)(1) expressly authorized that EPA to promulgate certain regulations involving a regulated substance, a substitute for a regulated substance, the reclaiming of a regulated substance used as a refrigerant, or the reclaiming of a substitute for a regulated substance used as a refrigerant. EPA is defining "substitute for a regulated substance" in this subpart for additional clarity that the use of this term in subsection (h) and in the regulations established in this rule differs from how the term "substitute" is used in subsection (i) and defined in 40 CFR part 84, subpart B.[45] The definition under subsection (h) makes clear that

[45] The definition for *substitute* in the 2023 Technology Transitions Rule is: "any substance, blend, or alternative manufacturing process, whether existing or new, that may be used, or is intended for use, in a sector or subsector with a restriction on the use of regulated substances and that has a lower global warming potential than the GWP limit or restricted list of regulated substances and blends in that sector or subsector." Under this definition, substitutes include regulated substances (*e.g.*, HFC-32 used in lieu of R-410A in commercial unitary AC), blends containing regulated substances (*e.g.*, R-454B used in lieu of R-410A in residential unitary AC), blends that do not

substitutes do not include HFCs or ODS and are instead a different category of substances. Examples of a substitute for a regulated substance that are encompassed by this definition under subsection (h) include but are not limited to HFOs, hydrocarbons (*e.g.*, propane, isobutane), ammonia (NH_4), and CO_2. A substitute for a regulated substance may be used neat or in a blend. However, a blend that contains a regulated substance is subject to the requirements that apply under this rule to regulated substances because those requirements apply to regulated substances regardless of whether the regulated substance is used neat or in a blend, as described above in section II.B of this preamble.

This distinction between substitutes and regulated substances for purposes of these regulations is also helpful for implementing certain provisions of this rulemaking that apply differently to regulated substances than to substitutes for regulated substances. For instance, the leak repair requirements apply to all regulated substances but only apply to substitutes for a regulated substance with a GWP greater than 53.

As noted in the Executive Summary of this preamble at section I.A., the terms "HFC" and "regulated substance" are used interchangeably in this preamble. Similarly, the term "substitute for an HFC" may be used interchangeably with "substitute for a regulated substance" in this preamble.

Comment: One commenter requested further clarification of the definition. The commenter argued that the definition of "regulated substance" in 40 CFR 84.106(a)(1) is easy to understand unlike the definition in 40 CFR 84.106(a)(2). The commenter highlighted the

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use a regulated substance (*e.g.*, R-441A used in lieu of R-410A in window ACs), substances that are not HFCs (*e.g.*, HFOs, hydrocarbons, R-717, and R-744 (CO_2)), and not-in-kind technologies (*e.g.*, finger-pump bottles in lieu of aerosol cans, or vacuum panels in lieu of foam insulation). (See 88 FR 73098, 73110, October 24, 2023).

complexity of determining the GWP of a substitute for a regulated substance, because the proposed methodology involved consulting three separate references that may vary in accessibility. The commenter requested that EPA provide a list of all substitutes for regulated substances with a GWP of 53 or higher, and that the Agency should not list substitutes for regulated substances with a GWP of less than 53, as doing so contributes to confusion.

Response: EPA responds that to the extent the commenter read the proposed regulations at 40 CFR 84.106(a)(1) and (2) as definitions, that interpretation misunderstands the intent of those provisions, which are designed to describe the applicability of the requirements in 40 CFR 84.106, not provide general definitions. To the extent the commenter intended to request the addition of definitions, EPA responds that subsection (c)(1) of the AIM Act lists regulated substances for the purpose of this and other rulemakings under the AIM Act, such as the Allocation Framework Rule (86 FR 55116, October 5, 2021) and the 2023 Technology Transitions Rule (88 FR 73098, October 24, 2023). The term "regulated substance" is defined in part 84, subpart A (40 CFR 84.3), with a current list provided in appendix A to part 84, and this appendix applies to the whole of part 84, including subpart C. Accordingly, EPA concludes it is not necessary to again list the regulated substances with a GWP greater than 53 in this action. While subsection (c)(3)(A) of the AIM Act authorizes the Administrator to designate as a regulated substance a substance that is not included in the list in subsection (c)(1) if certain criteria are met, EPA did not propose to add any regulated substance to the statutory list, and is not finalizing any addition. To the extent the commenter opposes such a listing, EPA finds that concern is beyond the scope of this rulemaking and thus requires no further response.

In response to the commenter's statements about the complexity of consulting multiple sources to determine the GWP of a substitute for a regulated substance, EPA notes that as described in section IV.C.1 of this preamble, the Agency is not finalizing the methodology to determine GWP of a substitute for a regulated substance, as proposed. EPA is instead finalizing the provisions to use a list of GWPs for various substitutes for regulated substances codified in the 2023 Technology Transitions Rule at 40 CFR 84.64. EPA is taking this approach because it agrees that having these GWPs in one concise list will limit confusion and enhance accessibility.

Virgin regulated substance. EPA proposed this definition to mean "any regulated substance that has not had any bona fide use in equipment except for those regulated substances contained in the heel or the residue of a container that has bona fide use in the servicing, repair, or installation of equipment."

EPA is modifying the final definition by removing the phrase "except for those regulated substances contained in the heel or the residue of a container that has bona fide use in the servicing, repair, or installation of equipment."

EPA's proposed definition of "virgin regulated substance" excluded refrigerant heels because EPA wanted to include refrigerant heels recovered from a container as recovered material for purposes of meeting the reclamation standard. However, EPA concluded that refrigerant heels are best described as "virgin regulated substances" because refrigerant heels have not had a bona fide use in equipment. EPA still recognizes the value of recovered heels, and thus EPA is not counting refrigerant heels that are removed from containers to contribute towards the 15 percent virgin material limit discussed in section IV.E.1 of this preamble.

The final definition of "virgin regulated substance" makes it clear that the introduction of a regulated substance to equipment, such as a refrigerant-containing appliance or fire suppression equipment, solely to convert its status to a "used" regulated substance and circumvent the intended requirements of this rulemaking is not permissible. This scenario, where a regulated substance is charged into equipment and subsequently recovered without any bona fide use, was brought to EPA's attention by stakeholders including during public stakeholder meetings as the Agency developed this rulemaking.[46] This issue was also raised in public comments on the proposed rule, as indicated in the comments summarized immediately below. Under the definition finalized in this rule, a regulated substance that has had no bona fide use in equipment would be considered a virgin regulated substance.

Comment: One commenter stated it is arbitrary and capricious to limit the definition of "virgin regulated substance" to refrigerant without a "bona fide use" in equipment because EPA does not define "bona fide use" and offers a limited explanation of the term. While the commenter agreed that only refrigerant that was used in an appliance for its intended purpose should qualify as recovered refrigerant, the commenter stated that it is not clear who the compliance obligation to make this determination of "bona fide use" falls on. The commenter further stated that the heel or residue of a container should not by default be considered "virgin" on the basis that it had a bona fide use, but instead be categorized based on the nature of its origin.

Multiple commenters requested that EPA define "bona fide use." One commenter stated that EPA should define a minimum length of time that refrigerant can be in equipment or some other objective criteria before it has had a "bona fide use." Another commenter stated that the term "bona fide use" has never been used in any definition of reclaim or reclamation either under title VI of the CAA, the AIM Act, or under the Air-Conditioning, Heating, and Refrigeration Institute's (AHRI) 700 standard for reclamation, and that EPA provides no justification for using

[46] EPA held stakeholder meetings for public input on November 9, 2022, and March 16, 2023, and also solicited feedback through a webinar for EPA's GreenChill Partnership program on April 12, 2023.

the term. Two commenters stated that it is unclear how EPA will determine whether refrigerant has had a "bona fide use." One commenter argued that not having a precise definition of "bona fide use" will undermine the refrigeration industry and lead to fraud, since entities could briefly pass refrigerant through chillers or other equipment and then remove it, process it, and send it out for "AHRI 700 certification." Lastly, one commenter stated that it is necessary to specify the use conditions from which refrigerant can be recovered in order to consider them reclaimed. The commenter argued this would help avoid the "potential laundering of newly produced material into the reclamation market."

A few commenters recommended that EPA distinguish between virgin refrigerant and recovered heel. One commenter requested that EPA define heel as "the residual amount of any regulated substance in a disposable cylinder." The commenter stated that residual amounts of regulated substances left in a disposable cylinder that has not had a bona fide use in equipment should be considered a "virgin regulated substance" whereas any residual amounts left in a disposable cylinder that has had a bona fide use in servicing, repair, or installation should be considered a recoverable substance for reclaim. The commenter remarked that these definitions should only apply to disposable cylinders and not other types of containers, as those heels are properly accounted for as virgin gas. Another commenter suggested the recovered heel should be considered in the context of cylinders rather than containers to avoid gaming the system of recovering from larger containers. Two commenters argued that EPA should define heel based on how the refrigerant was used or obtained, not on the type of container the refrigerant is in. A commenter gave an example of refrigerant left in an International Organization for Standardization tank or rail car. The commenter stated that under EPA's proposed definition of "virgin regulated substance," all of the unused refrigerant in these containers would need to be considered a "heel" and have to be reclaimed even though the refrigerant would still have the properties of virgin refrigerant. Another commenter discussed the possibility of large quantities of refrigerant being sent to a reclaimer as "bona fide heel" and asked for clarification on whether a bona fide heel could include the entire contents of a container. One commenter requested that the words "heel" and "residue" both be defined as "the vapor contents remaining in a container once the last drop of liquid has been removed."

Response: EPA disagrees that limiting the definition of "virgin regulated substances" to refrigerant that has not had a "bona fide use" in equipment is arbitrary and capricious and, after considering the comments on this topic, is finalizing a definition of "virgin regulated substance" to mean "any regulated substance that has not had any bona fide use in equipment." Commenters did not provide alternate definitions or approaches that would sufficiently address the concerns raised by commenters and stakeholders that entities could briefly pass refrigerant through equipment and claim the refrigerant was recovered. After considering the public input on this issue, the Agency concludes that it is important to finalize a definition of "virgin regulated substance" that indicates that virgin refrigerant is refrigerant that has not had bona fide use in equipment to address these concerns and help ensure the integrity of the reclamation requirements. In response to the comment on compliance obligation, EPA notes there is no obligation to make a determination of bona fide use under the definition itself; however, the definition informs compliance with other regulatory obligations, and to determine the compliance obligation one would need to examine the relevant regulatory requirement.

While EPA is not finalizing a definition for "bona fide use" in this rule, the Agency notes that at a minimum, refrigerant that has had a "bona fide use" is refrigerant that has been used in equipment to transfer heat between materials and then recovered for the purposes of reclamation or disposal. It is EPA's position that there is no set amount of time that a refrigerant should be used in a system before it is considered to have had a "bona fide use." Since there are a diverse range of applications in which refrigerants are used, and a variety of circumstances around that use, it is not appropriate to define a specific timeframe that applies for all refrigerants and applications. However, the amount of time refrigerant is used and other circumstances surrounding its use should together indicate that the use was for purposes of the equipment's maintenance or operation, rather than for the purpose of converting or attempting to convert the HFC's status to a "used" regulated substance and circumvent the requirements of this rule. Examples of "bona fide use" of refrigerant in equipment include, but are not limited to, refrigerant recovered from equipment once the refrigerant becomes contaminated, or refrigerant removed from an appliance due to changes in ambient conditions according to the provisions of seasonal variance in 40 CFR 82.152. Conversely, as indicated previously, passing a regulated substance through equipment and then recovering without an operational reason to do so (*e.g.*, without an indication of contamination or equipment malfunction), for the purpose of this treating the regulated substance as used, would not be considered bona fide use under this definition."

Even assuming the comments that the term "bona fide use" has not been used previously in other rulemakings or regulatory texts under CAA title VI or the AIM Act is true, EPA does not believe that is a reason to not use the term here. EPA's justification for using the term is to differentiate "virgin regulated substances" from those substances that have been used in equipment for their intended purposes and should no longer be considered virgin refrigerant. Some commenters expressed concern with the definition of recovery because there is the potential that virgin regulated substances would be charged into equipment or appliances and then recovered in an attempt to circumvent regulatory requirements established under this rule. EPA responds that the Agency considers the definition of "virgin regulated substance" for the purposes of these regulations under subsection (h) to address those concerns and reiterates that adding refrigerant to an appliance for the purpose of recovering it shortly thereafter, and then considering it "used" is not considered "bona fide use."

EPA did not propose and is not establishing a definition for residue or establishing various definitions for heel based on different types of containers. While in the RIA addendum and Economic Impact and Benefits TSD EPA estimates an average refrigerant heel at a specific percent of a container's nominal capacity, EPA acknowledges that there may be variations in the amount of HFCs that remain in a container.

The definition of "heel" in 40 CFR 84.3 to mean "the amount of a regulated substance that remains in a container after it is discharged or off-loaded (that is no more than 10 percent of the volume of the container)" applies to this rulemaking, as EPA is adopting definitions from 40 CFR part 84, subpart A for terms that are not separately defined in this rule. EPA clarifies that the heel could never be considered to include more than 10 percent of the container. EPA is not differentiating between refrigerant heels in different types of containers in this rulemaking to maximize the reclamation of refrigerant heel, except to clarify that the ten percent limit applies regardless of the type of container.

In response to comments about whether refrigerant should be classified by the nature of its origin, EPA notes that it is distinguishing refrigerant by its prior use, not the type of container it is in. As stated previously, refrigerant that has had bona fide use in equipment would be considered recovered material, whereas refrigerant that has not had a bona fide use in equipment would not be considered recovered. In response to the comment suggesting that EPA not specify that refrigerant heel or residue must include only vapor contents in this rulemaking, EPA has decided not to include such a specification, as the Agency understands that there may be situations where refrigerant heel is not entirely vapor, even if the amount of refrigerant heel remaining in the container is less than 10 percent of the container's volume.

3. What additional comments did EPA receive on definitions?

Some commenters suggested that EPA create defined terms that the Agency did not propose. Those terms are: reclaim, saturated hydrofluorocarbon, regulated substance, substitute, essential use, narrowed use limit, and technology transitions petition. For the reasons discussed in this section, EPA is not establishing definitions for these terms in this action.

Reclaim: Multiple commenters requested that EPA define "reclaim" or a phrase containing the word "reclaim" to improve the clarity of the rule. One commenter argued that reclaimed refrigerant referred to in 40 CFR 84.112(e) may be refrigerant that either has "not had bona fide use in equipment" or recovered refrigerant (removed from equipment), and that these requirements are not interchangeable because recovered material could be virgin. The commenter argued that EPA should clarify that reclaimed refrigerant must be non-virgin in origin. Another commenter argued that EPA could consider instituting a policy in which the amount of material that can be sold by an entity as reclaimed cannot exceed material recovered. Another commenter argued that EPA should define "certified reclaimed refrigerant" as "used (recovered) refrigerant … from a previously operational appliance" in line with the California Air Resources Board (CARB) definition.

Response: Subsection (b)(9) of the AIM Act provides a statutory definition for "reclaim; reclamation." This definition refers to the reprocessing of a recovered regulated substance to meet at least the purity described in standard AHRI 700-2016 (or an appropriate successor standard adopted by the Administrator), and that the purity of the reclaimed regulated substances must be verified using, at a minimum, the analytical method described in that standard. EPA promulgated a definition for "reclaim" in the Allocation Framework Rule (86 FR 55116, October 5, 2021) that is consistent with the definition provided by the AIM Act and that appears in 40 CFR 84.3. As provided in the regulations established in the final rule, for terms not defined in subpart C but that are defined in section 84.3, the definitions in section 84.3 shall apply, because the definition in 84.3 is also appropriate for the rule. EPA is not establishing a separate or different definition of "reclaim" in this action. This approach has the further benefit of providing consistency in the use of this term in this action with how it is used in other regulations implementing the AIM Act. Regarding the suggested definition of "certified reclaimed refrigerant," EPA notes that CARB's definition of that term includes practices meant to ensure that reclaimed refrigerant meets certain standards (such as being from a previously operational appliance).[47] EPA is not finalizing a definition of "certified reclaimed refrigerant," nor is EPA providing a definition specifying what standards reclaimed refrigerants have to meet beyond what is already required under the AIM Act. In provisions that appear outside of the definition section of the regulations established in this final rule, EPA is requiring that refrigerant contain no more than 15 percent virgin material as specified in the reclamation standard found in 40 CFR 84.112(a) and that reclaimed refrigerant must meet AHRI standards or other applicable purity specifications. Because these provisions address the standards that would apply for reclaimed refrigerant, EPA concludes that the definitions such as those suggested by the commenters are not necessary. As indicated by these requirements, to the extent that the comments suggest that

[47] Cal. Code Regs. Tit. 17, section 95373

reclaimed refrigerant cannot include any virgin HFCs, EPA disagrees. EPA further explains its reasons for allowing up to 15 percent virgin material in refrigerant that meets the reclamation standards established in the rule in section IV.E.1 of this preamble. EPA disagrees with the comment that a reclaimer should not be able to sell more reclaimed refrigerant than the amount of recovered refrigerant it received. Reclaimers often will hold recovered refrigerant until there is a sufficient quantity to process efficiently or until a change in market conditions. Therefore, the amount reported as reclaimed will not align with, and could potentially exceed, the amount reported as received.

Saturated hydrofluorocarbon: One commenter requested that EPA define "saturated" as it relates to a hydrofluorocarbon refrigerant and use that term throughout the rulemaking.

Response: EPA disagrees that there is a need to use or define the term "saturated hydrofluorocarbon" for purposes of this action. As described previously, subsection (c)(1) of the AIM Act lists 18 saturated HFCs, and by reference any of their isomers not so listed, that are covered by the statute's provisions, referred to as "regulated substances." EPA is also authorized to designate additional substances that meet certain criteria as regulated substances and one of those criteria is that the substance must be a saturated HFC. Further, the term "regulated substance" is defined in part 84, subpart A (40 CFR 84.3), with a current list provided in Appendix A to part 84, and this appendix applies to all of part 84 including subpart C. EPA has also explained that it is using the terms HFC and regulated substances interchangeably in this action. These provisions make clear which HFCs are addressed by this action, obviating any need to define "saturated" by regulation or use the term "saturated hydrofluorocarbon" throughout the regulations established in this rule.

Comment: One commenter argues that the rule should define the terms "regulated substance," "substitute," "essential use," "narrowed use limit," and "technology transitions petition." The commenter stated that these terms are important to understand the scope and applicability of the HFC phasedown program, and not defining these terms could create confusion and inconsistency in interpreting the rule.

Response: The terms "essential use, "regulated substance," "narrowed use limit," "substitute," and "technology transitions petition" appear to be similar to or the same as terms used in other regulatory programs under the AIM Act or the CAA. For example, the terms "essential use" and "regulated substance" are defined under the Allowance Allocation program (40 CFR part 84, subpart A), "narrowed use limit" is defined under SNAP (40 CFR part 82, subpart G), and "substitute" and "technology transitions petition" are defined under the Technology Transitions program (40 CFR part 84, subpart B), respectively. The commenter has not explained what relevance such terms would have to this rulemaking and, with the exception of the term "regulated substance" which is used in the regulations finalized in this action, the connection is not apparent to EPA. With respect to the term "regulated substance," as explained earlier in this section, because EPA is not defining that term separately in subpart C, the definition under 40 CFR 84.3 also applies in subpart C. No additional definition is needed. EPA further notes that while it is not establishing a definition for "substitute" in this rule, it is defining the term "substitute for a regulated substance" for purposes of the regulation, for the reasons discussed in section IV.A.2 of this preamble.

B. What types of equipment is EPA addressing under subsection (h)?

Subsection (h) of the AIM Act provides EPA authority to promulgate regulations to control, where appropriate, any practice, process, or activity related to the servicing, repair, disposal, or installation of equipment that involves HFCs or their substitutes, or the reclaiming of HFCs or their substitutes used as refrigerants. EPA interprets this provision to include authority to regulate, as appropriate, practices, processes, or activities related to any equipment that uses a regulated substance or a substitute for a regulated substance. Regulated substances and their substitutes are typically used in RACHP equipment as a refrigerant. Regulated substances and/or their substitutes may also be used in other types of equipment, such as equipment used in aerosols, fire suppression, solvent cleaning, foam blowing, and others. However, as explained in section II.B. of this preamble, subsection (h)(4) of the AIM Act expressly provides that any rulemaking under subsection (h) shall not apply to a regulated substance or a substitute for a regulated substance that is contained in a foam. Thus, this rulemaking did not propose and is not finalizing any requirements for regulated substances or their substitutes when they are contained in foams. Accordingly, EPA interprets its authority under subsection (h) to include promulgating regulations that control the types of practices, processes, or activities identified in subsection (h)(1) in any of those sectors, subsectors, or applications, with the limitation that EPA does not interpret its regulatory authority under subsection (h) to extend to HFCs or substitutes for HFCs when they are contained in foams.

EPA is establishing requirements for the servicing, repair, disposal, and/or installation of equipment in the RACHP and fire suppression sectors as described in sections IV.C through G. of this preamble. EPA interprets subsection (h) to provide authority that could be applied to practices, processes, or activities related to equipment across a broad range of sectors, subsectors, or applications that involve regulated substances and/or their substitutes. At this time, EPA is focusing on certain sectors and subsectors in the requirements finalized in this rulemaking. In future rulemakings, EPA may consider establishing requirements for equipment in other sectors, subsectors, or applications that involve regulated substances and/or their substitutes. The relevant sections of this preamble describe the requirements that EPA is establishing for equipment in certain sectors and subsectors and how EPA understands these sectors and subsectors as relevant for these requirements.

Where EPA is establishing requirements for certain sectors or subsectors, we intend to be consistent with how those sectors or subsectors are understood under other provisions of the AIM Act and/or CAA title VI that address the same sector or subsector, such as subsection (i) of the AIM Act, through the Technology Transitions program. EPA issued a final Technology Transitions Rule on October 24, 2023 (88 FR 73098), which provides additional detail on many of the same sectors and subsectors for which this action finalizes certain requirements under subsection (h). EPA also considered how those sectors or subsectors are addressed in the 2023 Technology Transitions Rule in finalizing this rule under subsection (h) of the AIM Act.

EPA is establishing certain provisions, as described later in this preamble, for certain equipment in applicable subsectors within the RACHP sector in this action. Such subsectors within the RACHP sector include: supermarket systems; refrigerated transport; and automatic commercial ice makers.[48] EPA is also establishing certain provisions for equipment in the fire suppression sector, as described later in this preamble.

[48] In other actions by EPA, such as the 2023 Technology Transitions Rule or rulemakings and/or notices under the SNAP program, EPA refers to this subsector as “automatic commercial ice machines” or “commercial ice machines,” respectively. EPA is clarifying that in this rulemaking, we intend for the term “automatic commercial ice makers” to cover the same types of refrigerant-containing equipment as those covered under “automatic commercial ice machines” in the 2023 Technology Transitions Rule or those covered as “commercial ice machines” under SNAP.

C. How is EPA addressing leak repair?

EPA is finalizing aspects of the proposed leak repair requirements, with modifications after consideration of the comments and information received on the proposed rule, as discussed in further detail in the following sections. The Agency is finalizing leak repair requirements for refrigerant-containing appliances with a charge size of 15 pounds or more that contain an HFC or substitute for an HFC with a GWP above 53. In the proposal, EPA bifurcated its compliance dates based on charge size, with refrigerant-containing appliances containing 50 pounds or more needing to comply within 60 days of publication in the **Federal Register** and refrigerant-containing appliances between 15 and 50 pounds having a compliance date of one year after publication in the **Federal Register**. In this final rule, after consideration of the comments, EPA is establishing one compliance date for all applicable appliances: January 1, 2026. The Agency views this change as reasonable to provide additional time for owners or operators with an appliance with a charge size of 50 pounds or more to comply with the leak repair requirements and avoid potential confusion due to varied compliance dates. Additionally, EPA is finalizing the narrow exemption of refrigerant-containing appliances in the residential and light commercial air conditioning and heat pumps subsector from the leak repair provisions in this final rule.

1. What refrigerants are subject to the leak repair requirements?

EPA is finalizing, as proposed, that the leak repair requirements apply to certain appliances that contain refrigerants that are composed in whole or in part of either a regulated substance or a substitute for a regulated substance with a GWP greater than 53, for reasons discussed in the proposal and in this final rule. To determine if the refrigerant contains a regulated substance, the owner or operator would consult the list of regulated substances provided in appendix A to 40 CFR part 84.[49] In the proposed rule, to determine whether an appliance containing a substitute for a regulated substance is required to comply with the leak repair provisions, EPA described the process for determining the GWP of regulated substances and/or their substitutes in the proposed Technology Transitions Rule (87 FR 76738, 76750, December 15, 2022). In the 2023 Technology Transitions Rule, published in the **Federal Register** on October 24, 2023 (88 FR 73098), EPA established a table listing the GWP values for substances that are not regulated substances. In this final rule, EPA is adopting the same approach for determining GWPs for those substances as in the final 2023 Technology Transitions Rule, codified at 40 CFR part 84, subpart B (40 CFR 84.64(a)-(c)) and, for consistency, is referencing the table at 40 CFR 84.64(b) for determining the GWPs of the listed commonly used non-HFC constituents. For purposes of this rulemaking, owners or operators should use the GWPs listed in that table to determine if the refrigerant contains a substitute for an HFC with a GWP greater than 53.

Comment: The Agency received multiple comments on the refrigerants subject to the leak repair provisions, including comments opposing a limit of 53 GWP for substitutes of HFCs. Some commenters suggested the Agency use a more generic value such as 100 or 150 to be consistent with the 2023 Technology Transitions Rule's approach. Another commenter expressed support for EPA's continued use of 100-year GWPs for the implementation and administration of provisions under the AIM Act and stated that they oppose the use of 20-year GWPs for the implementation of AIM Act rules. Finally, one commenter described issues with the proposal's resources to determine the GWPs of constituent parts of refrigerant blends or

[49] This list currently matches the list of regulated substances in subsection (c) of the AIM Act.

commonly used refrigerant alternatives. The commenter suggests that EPA compile a singular comprehensive list encompassing all substitute substances for GWPs exceeding 53. Additionally, the commenter stated that there is no reason to provide reference to substances with GWPs less than 53 to avoid confusion as these substitutes are not subject to this regulation.

Response: In response to these comments, EPA notes that it is finalizing, as proposed, that the leak repair requirements apply to refrigerant-containing appliances containing an HFC refrigerant or a substitute for HFC refrigerants that has a GWP above 53. EPA acknowledges comments seeking consistency across programs for GWP limits and finds it appropriate to continue to use 100-year GWPs for this rulemaking given the AIM Act uses 100-year GWPs. As discussed in the 2023 Technology Transitions Rule, the final limits in that rule were informed by a range of information, including the petitions, the Agency's evaluation consistent with the factors identified in subsection (i)(4) of the AIM Act, and comments received on that rule. Those considerations do not apply to this rulemaking, which is being undertaken under a different statutory provision and which establishes requirements that apply to certain substitutes for HFCs. As stated in the proposed rule under subsection (h), the GWP of 53 for substitutes for HFCs was chosen, given it is the lowest GWP of the HFCs that could be listed as a regulated substance under subsection (c)(3)(A)(i)(II) of the AIM Act. For purposes of this rulemaking, the Agency concludes it appropriate to parallel this statutory provision for the GWPs of the substances that could be designated as regulated substances under the Act. Regardless of GWP, any refrigerant that contains an HFC is covered under the leak repair provisions. Using a GWP of 53 for substitutes maintains consistency between the HFCs and their substitutes that are regulated under this rule under subsection (h). Moreover, the Agency notes that currently the vast majority of HFC refrigerants and refrigerant blends containing HFCs in equipment have much higher GWPs, often 20 to 50, or even more than 75 times as high as this cutoff. The Agency is aware of one HFC blend, IKON-A, currently in use for IPR which has a GWP below 53. However, the inclusion of a regulated HFC in the refrigerant blend means that any refrigerant-containing appliances using this blend are subject to the leak repair provisions of this final rule. In the future, EPA may find similar blends acceptable to use in specific applications, under other regulatory programs, but their applicability for the leak repair provisions of this final rule is subject to whether a blend contains an HFC or a substitute with a GWP above 53, not the GWP of the blend overall. Additionally, EPA acknowledges that over time the refrigerant market is likely to shift, particularly in light of the HFC phasedown under both the AIM Act and Montreal Protocol, the 2023 Technology Transitions Rule, and business decisions to use refrigerants that do not contain HFCs or a substitute with a GWP above 53.

EPA is establishing a lower-GWP threshold for the leak repair requirements in this final rule than it established under the 2023 Technology Transitions Rule for the use of an HFC in certain new equipment. EPA considers this lower threshold to be appropriate given the different goals of these regulations. One purpose for regulations under subsection (h), including the leak repair requirements, is minimizing releases of regulated substances from equipment. The 2023 Technology Transitions Rule was focused on restricting the use of higher-GWP HFCs in new equipment. Equipment that is compliant with the subsection (i) requirements may still be regulated under subsection (h) to minimize releases of HFCs from the equipment. Using a GWP of 53 as the cutoff under these regulations will address the release of substitutes with potentially comparable climate impacts to that of substances that are or could be listed as regulated substances. Further, if EPA were to establish a higher-GWP as the threshold, such as 150 or 700, that could create an incentive to switch to a substitute with a GWP above 53 but below that 150 or 700 GWP cut off to avoid a need to comply with leak repair requirements, even though those substitutes could have greater climate impact if released than some listed regulated substances.

Regarding the comments related to how to determine the GWP of substitutes, EPA responds that in the final rule, EPA has streamlined the process for owners or operators to determine the GWP of HFCs or substitutes for HFCs. An owner or operator can view GWP values for regulated substances by consulting the table in appendix A to 40 CFR part 84. Owners or operators can consult the table at 40 CFR 84.64(b) for determining the GWPs of listed commonly used non-HFC constituents to determine if the refrigerant contains substitute for an HFC with a GWP greater than 53. The list at 40 CFR 84.64(b) contains substitutes with GWPs less than 53 for purposes of the regulations under subpart B, but EPA disagrees that that inclusion would create confusion, as the regulatory text established in this rulemaking is clear that this list is being consulted for purposes of the subpart C regulations to determine whether a refrigerant contains a regulated substance with a GWP greater than 53.

Comment: Two commenters stated that EPA should consider safety aspects (*e.g.*, toxicity, flammability) of particular substances when deciding whether to apply the leak repair provisions, adding that subsection (h) specifically directs the Agency to ensure the safety of technicians and consumers. One commenter asked the Agency to consider whether a system is in direct or indirect contact with building occupants and charge size in its determination around applicability, rather than solely basing mandates on GWP. One of the commenters stated that the 53 GWP limit would drive more use of HFC-152, which the commenter claims is not a viable refrigerant and has historically been used agriculturally as a rodenticide.

The same commenter also requested that the Agency consider the provisions for leak repair under the parameters of safety and performance. The commenter specifically highlighted environmental concerns regarding fluorinated hydrocarbons that contain per- and polyfluoroalkyl substances (PFAS) or degrade into trifluoracetic acid (TFA). They suggested that the Agency require leak repair of systems with a charge size of 50 or more pounds for any HFCs, HFOs, or hydrochlorofluoroolefins (HCFOs) if the decomposition of said substance decomposes into TFA at levels greater than a 10 percent yield. The commenter used HFO-1234yf as an example, which produces byproduct yields of TFA greater than 10 percent.

Response: With respect to the comment suggesting that EPA consider performance as a parameter for these regulations, EPA notes that the statutory text under subsection (h)(1) does not mention consideration of performance as a separate parameter in establishing regulations under this provision. Further, the commenter did not provide any supporting analysis or technical information to explain why it would be useful to consider performance as a parameter in establishing the leak repair requirements, or how doing so might affect the final rule. Nothing in the comment suggests that performance of refrigerant-containing appliances would be negatively affected by this final rule or that this rule would prevent an owner or operator from addressing performance issues as appropriate. Thus, the Agency is not using performance as a separate parameter in establishing the final rule's leak repair requirements. Additionally, the Agency is aware that leaky equipment can have performance issues, and following the requirements in this rule may also have the effect of helping address those issues.

With respect to comments on safety, The Agency agrees that subsection (h)(1) of the AIM Act identifies ensuring the safety of technicians and consumers as one of the purposes for regulations under this subsection. EPA has a long history of screening the risks of ODS, HFCs, and their substitutes under SNAP, which for decades has provided a list of acceptable alternatives for a number of sectors. EPA does not view the GWP threshold, and the applicable refrigerants covered in the final rulemaking, as a significant safety risk to technicians and consumers if the refrigerants are properly managed. Refrigerants used in appliances have been thoroughly screened for risks associated with toxicity, flammability, asphyxiation, and physical hazards before being listed as acceptable for use under SNAP's comparative risk framework. While some refrigerants may be mildly flammable (*e.g.*, A2L refrigerants) or have toxicity (*e.g.*, ammonia), proper system design, engineering controls, and other techniques mitigate the risk for the use of refrigerants in appliances. EPA also notes the existence of other regulations that address the risks related to specific compounds, like ammonia (*e.g.*, EPA's Risk Management Program under the CAA). EPA disagrees with one commenter's suggestion to base the applicability of the leak repair requirements on whether the appliance is in direct or indirect contact with building occupants or other suggested factors (*e.g.*, toxicity). The commenter has not persuasively explained why such an approach would better serve the goals of ensuring the safety of technicians and consumers than having the leak repair requirements apply to equipment regardless of whether it is in direct or indirect contact with building occupants (or technicians and consumers, for that matter), particularly considering the rigorous evaluation of refrigerants under SNAP's comparative risk framework and other regulations addressing potential health and safety concerns. It is also not clear how such an approach would serve other statutory goals for regulations under subsection (h)(1) such as maximizing reclamation and minimizing releases of HFCs from equipment. Considering all three purposes, EPA concludes that it is appropriate to apply the leak repair requirements to equipment that is in both direct and indirect contact with consumers. With respect to the comment suggestion that EPA consider charge size in determining applicability of the leak repair provisions, EPA has considered charge size, as discussed in section IV.C.2 of this preamble. In response to one commenter's specific concern with HFC-152, the Agency responds that we are not aware of any use of HFC-152 in the RACHP sector in the United States. Further, as HFC-152 is a listed regulated substance, if it were used in refrigerants, the leak repair requirements would apply; thus, EPA disagrees that the GWP threshold of 53 for substitutes for HFCs would drive additional use of HFC-152. However, EPA is aware of significant use of HFC-152a with a GWP of 124, which is also a regulated substance and above the 53 GWP threshold.

EPA acknowledges the concerns one commenter raised regarding PFAS. There is currently no single commonly agreed definition of PFAS, and whether HFCs, HFOs, or HCFOs are classified as PFAS depends on the definition being used. EPA's PFAS roadmap sets timelines for specific actions and outlines EPA's commitments to new policies to safeguard public health, protect the environment, and hold polluters accountable.[50] This rule does not in any way establish a definition of PFAS, nor do the leak repair or other requirements in this final rule depend on a specific definition. As previously stated, SNAP already considers potential risks to human health and the environment via its comparative risk framework. Regardless of what definition of PFAS is used, not all PFAS are the same in terms of toxicity, for example. If a chemical has been found to present lower overall risk to human health or the environment, it might be found acceptable under SNAP regardless of whether or not it falls under a particular definition of PFAS. Potential risks to human health or the environment in regard to PFAS have been considered directly on a chemical-by-chemical basis and are not based on whether a specific chemical falls into a particular category of substances. Therefore, EPA elected in this final rule to require leak repair for all refrigerants that contain an HFC or an HFC substitute with

[50] Available at *https://www.epa.gov/pfas.*

a GWP above 53, without regard to whether or not the substance falls within a particular definition of PFAS. Under that approach, regulated entities are not required to use any particular HFC or HFC substitute, and the approach inherently permits equipment owners and operators to make decisions about what refrigerants are appropriate for use in their particular equipment.

Regarding the commenter's related concern regarding atmospheric decomposition of certain HFCs, HFOs, and HCFOs to TFA, EPA notes that TFA is a perfluorinated acid. Where TFA has been included in a particular definition of PFAS, it is often part of a class of chemicals containing more than 4,730 substances. According to the Montreal Protocol's Environmental Effects Assessment Panel (EEAP)[51] about 256 PFAS are in commercial use, with widely differing physical, chemical, and biological properties.[52] The 2022 EEAP Assessment Report[53] explained that one source of TFA in the environment is the degradation of some HFCs, HCFCs, HFOs, and HCFOs, while other potential sources of TFA include geogenic sources; effluents and releases from the manufacture of fluorinated chemicals; combustion and degradation of fluorinated chemicals in commercial and household waste; and biological and environmental degradation of chemicals such as certain pharmaceuticals and pesticides. The 2022 EEAP Assessment Report indicates that while TFA "is unlikely to cause adverse effects in terrestrial and aquatic organisms, [continued] monitoring and assessment are nevertheless advised due to uncertainties in the deposition of TFA and its potential effects on marine organisms." The report notes that "TFA does not bioaccumulate nor is it toxic at the low to moderate exposures currently measured in the environment or those predicted in the distant

[51] The EEAP is an advisory body to the Montreal Protocol Parties that evaluates the consequences of stratospheric ozone depletion and additional areas of potential importance to the Montreal Protocol.
[52] UNEP. 2022 Assessment Report of the Environmental Effects Assessment Panel. Available at: *https://ozone.unep.org/system/files/documents/EEAP-2022-Assessment-Report-May2023.pdf.*
[53] Id. at 49.

future." It further explains that because the HCFCs and HFCs are long-lived in the atmosphere, they distribute globally, and TFA from these substances is more evenly deposited. The HFOs and HCFOs have shorter lifetimes in the atmosphere, and deposition of TFA from these substances is likely to be more localized. This will result in greater concentrations near the locations of release. These greater concentrations are unlikely to present a risk to humans or the environment in these locations, but changes in concentration in surface water (or soil) would respond rapidly to releases. The 2022 Assessment EEAP Report states, "[monitoring] of the environment for residues of TFA would provide an early warning if trends in concentration indicate rapid increases." EPA reiterates that the SNAP program considers ecotoxicity as a criterion when evaluating alternatives under its comparative risk framework and has considered the potential impacts of TFA in past actions where SNAP found HFO-1234yf acceptable in certain end uses. The myriad studies EPA referenced in those actions all concluded that the additional TFA from HFO-1234yf did not pose a significant additional risk, even if it were assumed to be used as the only refrigerant in all refrigeration and air conditioning equipment (76 FR 17492–17493, March 29, 2011). The Agency intends to continue its approach to evaluating the potential risks from TFA in the future. However, in light of this scientific and technical information regarding the potential impacts of TFA from releases of HFCs, HCFCs, HFOs, and HCFOs, EPA does not agree that it is necessary to apply the leak repair requirements based on whether a refrigerant decomposes into TFA at levels greater than a 10 percent yield.

Comment: Some commenters stated that the leak repair provisions should apply to substitutes regardless of GWP as this would result in decreasing refrigerant emissions. One commenter suggested that the Agency omit the GWP threshold for "non-natural" (*i.e.*, fluorinated) substitute refrigerants. One commenter did not express an opinion on the proposed

GWP limit of 53 but appreciated that the Agency could extend beyond a GWP of 53 in the future.

Response: EPA acknowledges that in the future the Agency could consider whether a GWP limit lower than 53 is appropriate. One of the purposes stated in the AIM Act for regulations under subsection (h) is minimizing releases of regulated substances from equipment, and the 53 GWP threshold in this final rule parallels the lowest listed GWP of regulated substances in the AIM Act. Given the range of refrigerants currently in use that have a variety of properties and characteristics (including a wide range of GWPs), EPA concludes that it is appropriate to use a GWP of 53 as the threshold for substitutes for HFC that would be subject to leak repair requirements in this rulemaking, as that will address the release of substitutes with potentially comparable climate impacts to that of substances that are or could be listed as regulated substances, regardless of whether that substance is a fluorinated substitute. Further, non-HFC refrigerant substitutes below the 53 GWP threshold do not have commensurate climate impacts on HFCs or their covered substitutes. Therefore, EPA finds it is appropriate to not establish leak repair requirements for non-HFC substitutes with a GWP below 53 at this time. If EPA becomes aware of concerns related to this limitation as the refrigerant market shifts to lower-GWP substitutes for HFCs, EPA could consider revisiting the requirement via a notice-and-comment rulemaking. By finalizing a GWP threshold of 53, as well as the provision to include refrigerant blends with any HFCs as components regardless of their GWPs, EPA is not precluding further consideration of a lower-GWP threshold in the future.

The Agency is finalizing leak repair requirements for appliances that use a refrigerant blend that contains an ODS and an HFC or a substitute for an HFC with a GWP above 53 to simultaneously meet the leak repair provisions promulgated under CAA section 608 at 40 CFR

82.157, and the provisions in this action, to the extent that either set of requirements is applicable. EPA intends for the leak repair requirements in this rulemaking to be sufficiently consistent with the requirements at 40 CFR 82.157 such that both sets of requirements could be met for refrigerant-containing appliances that use a refrigerant blend containing an ODS and an HFC or a substitute for an HFC with a GWP above 53 and that have a full charge of 50 or more pounds of refrigerant. Due to the difference in charge sizes for equipment covered by 40 CFR 82.157 and the leak repair requirements finalized in this action, such appliances using such a refrigerant blend with a charge size of 15 pounds or higher but below 50 pounds are only subject to the requirements under subsection (h).

Comment: One commenter stated that the proposed requirements for owners and operators with an appliance using both ODS and HFCs were unnecessarily burdensome. The commenter expressed the view that any differences with the 40 CFR 82.157 ODS requirements (*e.g.*, leak rate calculations, lowering the proposed threshold for chronically leaking appliances) would significantly increase the complexity and burden of requirements. Another commenter requested clarification on the types of appliances containing ODS that would be subject to the leak repair provisions. The commenter posited two scenarios. One would imply that all appliances containing only ODS refrigerant are exempt from the provisions of the rule, and the other would imply that appliances regulated by 40 CFR part 82, subpart F are excluded from this rule’s leak repair requirements. One commenter stated that having the requirements be consistent with those for ODS would make it easier for the many end users who are already required to comply with ODS substance requirements.

Response: EPA acknowledges that where appropriate, consistent leak repair requirements could smooth implementation of both programs. As described in this section, the conclusion that refrigerant-containing appliances using a refrigerant blend containing an ODS and an HFC or a substitute for an HFC with a GWP above 53 is subject to leak repair requirements under both CAA section 608 and subsection (h) of the AIM Act is the result of how applicability is determined for these provisions. EPA intends for the leak repair requirements in this rulemaking to be sufficiently consistent with the requirements under CAA section 608 such that both set sets of requirements could be met for refrigerant-containing appliances using an ODS/HFC blend. The Agency did not reopen the requirements promulgated under CAA section 608, codified at 40 CFR part 82, subpart F, in its proposed rule under subsection (h) of the AIM Act and is not amending those regulations in this final rule, including the applicability provisions through this action. Thus, those provisions continue to apply for appliances using a refrigerant that contains an ODS with a full charge of 50 or more pounds of refrigerant.

In consideration of (h)(3), which authorizes EPA to coordinate with other similar EPA regulations, including the extensive experience in implementing leak repair requirements under CAA section 608 codified at 40 CFR 82.157, EPA is finalizing many provisions that are identical or similar to those in 40 CFR 82.157. Examples include the methodology for determining the leak rate, the timing for repairs, and verification tests. One notable difference between the regulatory requirements under CAA section 608 and subsection (h) of the AIM Act is the applicable charge size, which is discussed in section IV.C.2 of this preamble. The similarities in these requirements should facilitate compliance with both sets of requirements where both apply. Accordingly, EPA does not agree with the comments that complying with the ODS and HFC leak repair provisions simultaneously would be unduly burdensome. Furthermore, the commenters did not provide sufficient data to support this supposition or to allow EPA to fully evaluate commenter’s claims of undue burden and other potential approaches to addressing such burden. The grants of authority under CAA section 608 and subsection (h) of the AIM Act are not identical, and more than 30 years have passed since the issuance of the initial regulations under CAA section 608. Therefore, in some instances, this final rule does differ from the CAA section 608 regulations. EPA is not establishing an exemption from the requirements in this rule for equipment that is subject to the requirements under 40 CFR part 82, subpart F, because, if such equipment also contains an HFC or a substitute for an HFC with a GWP above 53, it is appropriate for it to comply with the leak repair requirements under subsection (h)(1). This approach ensures that such equipment is subject to requirements designed to meet the direction under and the particular statutory purposes identified in subsection (h), such as maximizing reclaim and minimizing releases of HFCs from equipment.

To address one commenter's request for clarity on the overlap of leak repair requirements for appliances containing ODS and HFCs and their substitutes, EPA reiterates that owners and operators would only need to comply with the leak repair provisions under both 40 CFR part 82, subpart F and 40 CFR part 84, subpart C if the refrigerant-containing appliance uses a refrigerant containing ODS and an HFC or HFC substitute with a GWP greater than 53. If an appliance uses a refrigerant that solely contains ODS (and meets the other applicability criteria), it is subject to 40 CFR part 82, subpart F leak repair requirements, but not the leak repair requirements under this final rule. Conversely, if an appliance solely contains an HFC or HFC substitute with a GWP greater than 53 (and meets the other applicability criteria) the owner will need to comply with the leak repair provisions in this final rule, but not the leak repair requirements in 40 CFR 82.157. EPA is not aware of any widespread use of ODS/HFC blends. However, to the extent such blends are in use, requirements under the CAA title VI regulations and the CAA itself restrict use of ODS in new and existing equipment, thus further limiting the likelihood of one appliance being subject to the two sets of leak repair requirements.

2. Appliances with what charge size are subject to the leak repair requirements?

EPA is finalizing that, with certain exceptions, appliances with a charge size of 15 pounds or more of refrigerant that contains an HFC or a substitute for an HFC with a GWP greater than 53 are subject to the leak repair requirements under subsection (h) of the AIM Act, for reasons discussed in the proposal and in this final rule. This establishes a lower threshold than in the regulations established under CAA section 608 nearly 30 years ago. As discussed in the proposal, applying the leak repair requirements to more equipment will reduce the release of HFCs from equipment and increase the amount of HFCs that will be available for recovery and reclamation because of avoided releases of HFCs from leaks. The AIM Act provides a schedule for a phasedown of HFCs, as opposed to the phaseout of ODS under the CAA. Therefore, the introduction of HFC-containing appliances indefinitely, which is a notable difference from the restrictions on ODS under the CAA. As described more fully in section II.B. of this preamble, subsection (h)(1) of the AIM Act tasks the Agency with promulgating "regulations to control, where appropriate," certain practices, processes, or activities for certain purposes, including minimizing the release of regulated substances from equipment and maximizing the reclamation of regulated substances. EPA interprets the phrase "where appropriate" in subsection (h)(1) to provide it discretion to reasonably determine how the regulations under subsection (h)(1) will apply, including by making determinations about the charge size threshold of equipment that is subject to the leak repair requirements. Considering both purposes of minimizing the release of HFCs from equipment and maximizing reclamation, EPA concludes it is appropriate to use a 15-pound threshold for the leak repair requirements under this rule to further serve these purposes.

By establishing an applicable charge size of 15 pounds or more of refrigerant, with certain exemptions, the universe of affected appliances covered by the leak repair requirements under subsection (h) is larger than the universe of appliances containing ODS refrigerants and subject to the leak repair requirements provisions at 40 CFR 82.157. For example, the applicable charge size of 15 pounds or more of a refrigerant that contains an HFC or substitute refrigerant with a GWP above 53 is expected to cover certain appliances in the following subsectors:

- Train air conditioning;
- Passenger buses (*e.g.*, school, coach, transit, and trolley buses);[54]
- Refrigerated transport – rail;
- Large retail food remote condensing units (*e.g.*, cold rooms in supermarkets); and
- Commercial unitary air conditioning (*e.g.*, a system for a mid-sized office building).

EPA is establishing a 15-pound refrigerant charge size threshold for refrigerant-containing appliances subject to the subsection (h) leak repair requirements based in part on consideration of an analysis of refrigerant-containing appliances where HFCs or their substitutes are currently being used and where they are expected to be used in the coming years. EPA conducted an analysis[55] using the Vintaging Model to estimate the quantity of refrigerants used in equipment of varying charge sizes (also called the “installed stock”). The Vintaging Model tracks the transition from ODS to substitutes including HFCs by modeling the total pieces of equipment and average charge sizes—which could vary over time based on vintage and the ODS

[54] “Bus” is defined at 40 CFR 1037.801 and means “a heavy-duty vehicle designed to carry more than 15 passengers. Buses may include coach buses, school buses, and urban transit buses.”
[55] U.S. EPA. 2023. EPA’s Vintaging Model representing the Allocation Framework Rule as modified by the 2024 Allocation Rule RIA addendum and the 2023 Technology Transitions Rule RIA addendum. VM IO file_v4.4_02.04.16_Final TT Rule 2023 High Addition.

or substitute used—in over 60 subsectors. Doing so allows us to analyze the pieces of equipment and total refrigerant in equipment by charge size. A current snapshot of the model's estimates of the installed stock of HFC and HFC substitute refrigerants in 2025 shows that approximately 42 percent of refrigerants (on a weighted carbon dioxide equivalent (CO_2e) basis) are used in appliances with a charge size above 15 pounds. In evaluating where leak repair could be effective at reducing releases of refrigerant from appliances (*e.g.,* trains and passenger busses), which may result in additional environmental benefits, as well as looking at changes in the RACHP market and aftermarket over the past few decades, EPA finds it appropriate to establish a charge size threshold of 15 pounds for refrigerant-containing appliances to be subject to the leak repair requirements. As a general matter, appliances containing less than 15 pounds of refrigerant are significantly more likely to be hermetically sealed (and thus less prone to leaking) and more likely to be replaced rather than repaired.

EPA considered the statutory purposes in subsection (h)(1) to maximize the reclaiming and minimize the release of regulated substances from equipment when setting the threshold for appliances covered for the leak repair requirements. These purposes guided EPA's considerations in exploring different charge sizes, as did the Agency's consideration of what regulations would be "appropriate" to control the relevant practices, processes, or activities to serve these purposes, consistent with subsection (h)(1).

Comment: EPA received many comments supporting the 15-pound charge size threshold. One commenter expressed support of EPA's proposed rule, stating that HFC emissions do not respect state boundaries and a federal approach is critical to avoid piecemeal regulations and facilitate the implementation of industry-wide emissions reductions. Another commenter stated that it was reasonable for EPA to have a different charge size threshold than the ODS regulations to preserve the supply of HFC refrigerants. Several commenters in favor of the proposal recommended EPA consider a lower charge size threshold (*e.g.*, five pounds) to avoid additional GHG emissions. One commenter suggested a charge threshold size between one and five pounds to include smaller appliances and achieve additional reductions to HFC emissions. Another commenter stated that lowering the charge size threshold decreases the incentive for owners and operators to replace one large system with smaller systems to skirt regulatory obligations. One commenter stated that EPA's estimates (on a weighted CO_2e basis) show that appliances below 15 pounds account for around 39 percent of total HFC refrigerants. The commenter suggested that lowering the threshold will close the gap on HFC management and build on existing recordkeeping requirements for technicians who evacuate refrigerant from appliances with a full charge between 5 and 50 pounds.

Response: EPA is finalizing the 15-pound charge size threshold as proposed. The Agency acknowledges the numerous supportive comments for the 15-pound charge size. Since the 1990s, when EPA established the 50-pound charge size for ODS refrigerant-containing appliances, there have been changes in appliance design, use, and practices. In 2016, EPA updated the leak repair program under CAA section 608, partly in consideration of these changes. For the most part, the leak repair provisions for HFCs finalized in this action are consistent with that rule. However, EPA did not change the 50-pound threshold in the 2016 CAA Section 608 Rule, and thus the 15-pound threshold is different from the threshold under the CAA section 608 regulations at 40 CFR part 82, subpart F. Through this notice-and-comment rulemaking, the Agency provided notice of this lower threshold level and considered the public comments received. The Agency's rationale for a 15-pound threshold is discussed in the proposal and in section IV.C.2 of the preamble. As discussed previously, applying the leak repair requirements to more refrigerant-containing appliances will reduce the release of HFCs from said appliances and increase the amount of HFCs available to recover that would be otherwise lost because of leakage from appliances. Furthermore, the HFC phasedown will not eliminate the use of HFCs in the U.S. market, so there may be continued introduction of new HFC-containing appliances; thus, proper management of these refrigerant-containing appliances is necessary for the successful implementation of the HFC phasedown, and to ensure there is an adequate supply of reclaimed HFCs to support the existing installed base of HFC-containing appliances. The Agency also disagrees with one commenter's statement that the lower threshold will disincentivize owners or operators from installing multiple smaller refrigerant-containing appliances to skirt the leak repair requirements of this final rule. The 15-pound threshold is intended to be low enough to hinder efforts to avoid applicability of the leak repair requirements and ensures a sizeable proportion of refrigerant-containing appliances are subject to the leak repair requirements of the final rule. After further evaluation informed by commenters, EPA is finalizing a 15-pound charge size requirement for HFC and covered HFC substitute refrigerants.

EPA took comment on, but is not finalizing, leak repair requirements for equipment with charges of less than 15 pounds. One commenter stated that a lower threshold could bridge that gap on HFC emissions by capturing more refrigerant-containing appliances. While EPA agrees that there could be instances where this may reduce releases of refrigerants, we also note that many refrigerant-containing appliances with charge sizes under 15 pounds are hermetically sealed, which means they are less leak prone; these refrigerant-containing appliances are also normally disposed of once they stop functioning properly, rather than repaired for further use. The commenter stated that lowering the threshold would build on existing requirements to recover refrigerants from small appliances (5 pounds or less) under 40 CFR 82.155, which apply to HFCs. However, as previously discussed, these types of refrigerant-containing appliances are at low risk for leakage. Although the safe disposal requirements for small appliances under CAA section 608 do not address leaks, the provision ensures that the refrigerant within these appliances is not released at disposal. Further, EPA notes that refrigerant-containing appliances between 5 and 15 pounds are still subject to the venting prohibition under section CAA section 608(c) (codified in EPA's regulations 40 CFR 82.154(a)(1), which prohibits the knowing venting or release of HFCs from refrigerant-containing appliances during the maintaining, servicing, repairing, or disposing of the appliance. While EPA agrees that there could be reasons to consider lowering the charge size threshold to five pounds or lower, the Agency would want to further evaluate various aspects of a lower threshold before proposing to establish one, such as the potential for such a threshold to serve the purposes identified in subsection (h)(1), whether there are particular considerations about what types of requirements might be appropriate for such appliances, including common design elements for these appliances, and any information available about the occurrence or cause of leaks in such appliances.

Comment: A number of commenters opposed the 15-pound charge size threshold for leak repair and stated that the threshold is not cost-effective, may confuse owners and technicians, will increase repair cost, and will double the regulatory responsibilities for industry as compared to CAA section 608 regulations, without commensurate environmental benefits. Several commenters provided estimates for the number of refrigerant-containing appliances subject to the leak repair requirements, which ranged from two to five times greater than the number of refrigerant-containing appliances that would be subject to the leak repair provisions at a 50-pound threshold. Several commenters requested that EPA require leak repair for appliances with a full charge of 50 or more pounds as this is the current ODS threshold under CAA section 608 regulations. One commenter claimed that it could be difficult to effectively distinguish between units charged with HFCs, ODS, or a combination of both for purposes of compliance, and that it would be difficult for equipment owners and certified technicians to determine the applicability threshold for any particular refrigerant/appliance. The commenter asserted that EPA should maintain the 50-pound threshold for applicability to promote compliance, maintain consistency in operations, and avoid unjustified costs. Another commenter urged EPA to direct leak repair requirements to larger appliances with a charge size of 50 pounds or more, as technological advancements have allowed for smaller charge sizes in appliances and therefore have reduced the potential harm to the environment in the event of a leak. The commenter also asserted that the 15-pound threshold could discourage manufacturers from improving the efficiency of refrigeration appliances to reduce overall refrigerant usage. One commenter suggested EPA wait a period of time (*e.g.*, five years) from the effective date of the final rule to see if there is a reduction in HFC use and their corresponding emissions. The commenter recommended that if substantial HFC use and emissions reductions are not observed, then EPA could evaluate and propose a new applicability threshold. Alternatively, the commenter suggested EPA could establish a charge size threshold at 40 pounds, as there have been technological reductions in charge sizes due to the phaseout of ODS. A few commenters recommended that EPA increase the threshold from the proposed 15 pounds to 30, 40, or 50 pounds to better align with CAA section 608 regulations. One commenter claimed the 15-pound threshold does not provide enough environmental benefits to justify the cost increases to small business owners, local school systems, and mass transit operators. The commenter stated that while a 50-pound threshold is preferable, a 30-pound threshold would mitigate some of these costs and challenges. Another commenter stated that the 15-pound threshold was too low and would dramatically increase the number of affected appliances; suggesting that a 30-pound threshold would be more appropriate and still expand upon the CAA regulations.

Response: EPA disagrees with commenters that the 15-pound threshold will confuse technicians and facility owners. While this lower threshold will affect different sizes and types of refrigerant-containing appliances than the 50-pound threshold for ODS appliances, the leak repair activities are consistent with the subpart F requirements. Through this notice-and comment rulemaking the Agency informed stakeholders of this lower threshold level and explained the Agency's rationale for a 15-pound threshold in section IV.C.2 of this preamble. EPA intends to provide information to the regulated community on its website and additional communication about the requirements to affected stakeholders. EPA also disagrees that owners or operators would have difficulty determining what refrigerants are being used within a refrigerant-containing appliance or that they would have difficulty determining the charge size of a refrigerant-containing appliance. An owner or operator should be fully aware of the type of refrigerant is being used in a refrigerant-containing appliance, and the determination of an appliance's full charge (as described in section IV.A.2 of this preamble) is the same as its use under the CAA section 608 regulations.

The Agency disagrees with a commenter's claim that the 15-pound threshold would uniquely burden small businesses, schools, and mass transit operators. Small businesses and schools, depending on equipment type, may fall under the narrow leak repair exemption for residential and light commercial air conditioning and heat pumps, easing some of their regulatory burden. The final rule's leak repair provision may affect operators of air conditioning on mass transit (*e.g.*, trains) and school buses, but the commenter did not provide specific evidence to support their claim that the leak repair requirements would increase costs to an extent that it unduly burdens these refrigerant-containing appliance owners.

EPA disagrees with a commenter's suggestion to pause the compliance date of the leak repair provisions to see if there is a substantial reduction in HFC use and emissions. The Agency notes that the HFC phasedown is substantially reducing the production and consumption of HFCs; thus, the overall use of virgin HFCs is going to be reduced as the phasedown progresses. However, as previously stated the phasedown will not eliminate the production and consumption of HFCs, and specific measures are necessary to limit the impacts of HFCs on the environment and ensure that the supply of HFC refrigerants is available for use in existing systems. This action is focused on implementing subsection (h) of the AIM Act, which establishes distinct authorities focused on minimizing the release of HFCs and maximizing the recovery of HFCs for reclamation. The vast majority of HFCs are used in the RACHP sector and its subsectors; thus, leak repair requirements for this sector are vital to minimizing the release of HFCs and maximizing reclamation. Additionally, in the context of the HFC phasedown, not establishing requirements to limit the release of HFCs will create supply issues as the phasedown progresses. Therefore, the timing of the leak repair requirements in this final rule is vital to the implementation of the HFC phasedown and ensures that a supply of reclaimed HFCs is available for owners or operators to continue to use HFCs for their refrigerant-containing appliances. The Agency agrees that additional data may inform future decisions under subsection (h) and more broadly under the AIM Act. Such information could lead to a future notice-and-comment rulemaking that may consider a lower threshold for refrigerant-containing appliances subject to leak repair requirements. However, based on the data available now, the Agency concludes that it is appropriate to proceed with the leak repair requirements for appliances with a full charge size of 15 pounds or more and with a compliance date of January 1, 2026, as part of implementing subsection (h).

The Agency also disagrees with some commenters' assertions that the 15-pound threshold would increase the number of refrigerant-containing appliances subject to leak repair by a factor of two to five times the number of affected appliances under CAA section 608. The final rule will include a substantial number of new appliances under the leak repair provision but not the extent claimed by the commenter. Vintaging Model estimates on the total number of refrigerant-containing appliances subject to the leak repair provisions of the final rule are estimated to affect 971,133 appliances with a charge size between 15 and 50 pounds and 580,653 appliances with a charge size above 50 pounds. As previously stated, EPA understands that the 15-pound threshold does increase the number of refrigerant-containing appliances subject to leak repair. This decision was based on EPA's evaluation of changes in the RACHP market and aftermarket (*e.g.*, the overall reduction of refrigerant charge size). With these considerations, EPA determined that capturing refrigerant-containing appliances at charge sizes below 50 pounds will further serve the purposes of minimizing the release of HFCs from equipment. Therefore, the Agency finds it appropriate to establish a charge size threshold of 15 pounds for refrigerant-containing appliances to be subject to the leak repair requirements.

For these reasons EPA also disagrees with one commenter's claim that refrigerant-containing appliances below 50 pounds should not be subject to the leak repair provision because their reduced charge size has mitigated their potential to harm the environment. The extension of the leak repair requirements to refrigerant-containing appliances below 50 pounds was found to be feasible because of the technological improvements to refrigerant charge size over decades. These changes in charge size in the RACHP sector informed EPA's decision to capture appliances between 15 and 50 pounds because those appliances still contain HFCs or covered substitutes that have a detrimental effect on the environment. The reduction in charge size does mitigate the total amount of refrigerant that is capable of being lost during a leak event, but it does not account for the proper management of refrigerant-containing appliances and fixing leaks within said appliances. EPA also disagrees with the commenter's assertion that lowering the threshold to 15 pounds will deter manufacturers from continuing to make technological events to appliance charge size. Manufacturers' incentives to create smaller refrigerant-containing appliances are not solely based on the charge size threshold for leak repair in this final rule, nor was this the case in the context of the 50-pound threshold under the CAA section 608 regulations. The commenter did not provide additional information to sufficiently reason that this would be the case, and EPA notes that charge size reductions have occurred over decades because of improvements to appliance design and energy efficiency.

EPA acknowledges commenters' concerns regarding the costs and benefits associated with leak repair. Further discussion on the costs and benefits associated with this final rule and discussions on the draft RIA Addendum and *Economic Impact and Benefits* TSD can be found in section VI.B of this preamble. EPA is not relying on those analyses as a record basis for this rulemaking, and the Agency would reach the same conclusions on the suitability of a 15-pound charge size threshold without those analyses. However, the analyses in the TSD reflect that the leak repair requirements in this final rule will provide several benefits to owners or operators and EPA acknowledges that certain costs will be associated with the implementation of the leak repair provisions. First, the leak repair requirements of this rulemaking are likely to provide owners or operators information that leaks are occurring earlier than would have otherwise been known. Fixing those leaks will reduce the amount of refrigerant needed to be added to the system thereby reducing refrigerant costs for the owner/operator. Secondly, a system that is operating with less than the full charge of refrigerant is likely to consume more energy or not provide the desired cooling effect, both of which increase the owner's operating costs. As an example, a unit cooler with 15 to 50 pounds of refrigerant might be used for a large cold room. If that cooler is not providing the cooling needed, products could spoil, representing a large cost to the owner, in addition to the costs of the additional energy used to operate the off-specification equipment, that is likely to greatly outweigh the costs of performing the leak inspection and repair requirements of this rulemaking. Regarding the issue of cost-effectiveness of a 15-pound threshold raised by some commenters, the Agency refers the reader to section VI.B of the preamble. The Agency reiterates that this rulemaking is designed to serve the purposes identified in subsection (h)(1) of the AIM Act, including maximizing reclamation and minimizing the release of regulated substances from equipment.

Comment: A commenter in opposition of the 15-pound threshold claimed that the reasoning for changing the charge size threshold appears to be arbitrary and capricious. The commenter claims the reduction is unmerited based on the availability of newer technologies using smaller charge sizes. They further assert the replacement of older appliances with new and more efficient appliances is one of the goalposts of the AIM Act. The commenter stated that applicability of the leak repair and detection requirements will act as a deterrent for replacing appliances and is unnecessary and unreasonable given reductions in available HFC stocks. The Agency also received a similar comment stating that the proposal did not provide clear justifications for lowering the charge size threshold below 50 pounds.

Response: The Agency disagrees that the 15-pound threshold is arbitrary and capricious. Subsection (h)(1) of the AIM Act directs the Agency to promulgate "regulations to control, where appropriate," certain practices, processes, or activities, for certain purposes, including minimizing the release of regulated substances from equipment and maximizing their reclamation of regulated substances. EPA interprets the phrase "where appropriate" in subsection (h)(1) to provide it discretion to reasonably make determinations on how the regulations should apply including, among other things, to selecting an appropriate charge size threshold for refrigerant-containing appliances subject to the leak repair provision. As previously stated, the Agency is applying leak repair requirements to more refrigerant-containing appliances than under the CAA section 608 rules to reduce the release of HFCs from said appliances and increase the amount of HFCs available for recovery that would otherwise be lost because of leakage from such appliances. Given that the purposes identified for regulations under subsection (h)(1) include maximizing reclamation and minimizing release of HFCs from equipment, EPA interprets the intent of subsection (h)(1) to be that the regulations promulgated under it may apply as broadly as needed to serve those purposes, while also being mindful of the statutory text indicating that the controls should apply "where appropriate." EPA finds it appropriate to apply the leak repair requirements to equipment with a charge size below 50 pounds for several reasons. Technological achievements have lowered the charge sizes of many refrigerant-containing appliances, such that using a charge size threshold of 50 pounds today would leave many such appliances unregulated. Refrigerant-containing appliances between 15 and 50 pounds still contain climate-damaging HFCs or HFC substitutes that are appropriately addressed under subsection (h)(1). Such appliances can still leak, and if they are not repaired, could release refrigerant, which would not be available for reclamation once it had leaked. Thus, applying the leak repair requirements to this equipment is part of the regulatory design to better serve the purposes identified in subsection (h)(1) of maximizing reclamation and minimizing release of

HFCs from equipment. With respect to the commenter's reference to reductions in HFC stocks, EPA notes that the HFC phasedown will greatly reduce the overall consumption and production of HFCs but will not eliminate their use in the U.S. market. Therefore, continued introduction of HFC-containing appliances may still occur, and EPA concludes it is appropriate for theses appliances to be subject to these requirements for the reasons described earlier in this response. For these reasons, EPA finds the 15-pound threshold as appropriate for serving the purposes outlined in subsection (h).

The Agency disagrees with the commenter's assertion that the 15-pound threshold would deter the transition to newer, more efficient refrigerant containing appliances, as in the Agency's experience several factors inform the decision of whether to replace equipment and if so what to replace it with (such as the age, functionality, and costs of operating the existing equipment, and the price of new equipment and costs of operating that equipment). EPA notes that the commenter did not provide additional information to support their assertion that such deterrence would actually occur. EPA is not clear on what the commenter is referring to when it says that one of the goal posts of the Act is the replacement of older equipment with newer and more efficient equipment. To the extent the comment is referring to the implementation of subsection (i) of the AIM Act, EPA clarifies that those provisions are out of the scope of this rulemaking and thus any comment addressing those requires no response. To the extent that the comment pertains to appliances subject to the leak repair requirements in this final rule the Agency notes the overall applicability of appliances is subject to whether or not they contain an HFC or substitute for an HFC with a GWP greater than 53. The final 2023 Technology Transitions Rule applies certain GWP-based restrictions on use of HFCs in new equipment in certain sectors or subsectors in which those HFCs are used. If an equipment owner were to decide to replace a refrigerant-containing appliance above the 15-pound threshold with a new refrigerant-containing appliance that is subject to under 2023 Technology Transitions Rule, they would need to consider compliance with those requirements. If they also wish to avoid the applicability of leak repair requirements established in this rule to the new appliance, they may have options that would achieve that goal. For example, an owner or operator may be able to select an appliance that uses a refrigerant that does not contain an HFC or a substitute with a GWP greater than 53. However, if they are selecting a refrigerant-containing appliance that uses HFCs, it would not serve the purposes identified in subsection (h)(1) of maximizing reclamation and minimizing release of HFCs from equipment to allow that refrigerant-containing appliance to avoid application of the leak repair requirements simply because it is new, even it is more efficient. Thus, their inclusion in the leak repair requirements at the 15-pound threshold is warranted.

Comment: One commenter stated that many food industry leaders are part of the GreenChill voluntary partnership that made charge size reduction a priority and challenged equipment manufacturers to lower the amount of refrigerant needed in the retail food industry. The commenter asserted that the current charge size threshold of 50 pounds has served as a motivation to select lower-charge appliances, which leak less refrigerant in situations where catastrophic leaks occur and stated that the proposed threshold penalizes food retailers for the progress under the GreenChill partnership. The commenter asserts that the lower threshold would decrease any motivation for food retailers to purchase expensive appliances that operate at lower charge sizes below 50 pounds. The commenter also expressed concern that many smaller appliances would need to be added to a company's recordkeeping, because appliances not previously covered under section 608 would not have had their full charge data captured.

Another commenter indicated that the provision poses a significant challenge to a cost-conscious industry using centralized HFC systems which are reliable and remain cost-effective for years if well maintained. The commenter asserted that the leak repair requirements would force owners or operators who have recently transitioned to HFO systems to transition again or to cause smaller facilities to transition to fan systems which may paradoxically increase emissions from electricity generation. The commenter also stated that the rule disproportionately impacts owners or operators in states with higher heat indexes and limited alternative chilling methods.

Response: The Agency disagrees that the final rule's 15-pound threshold for leak repair unduly burdens the retail food industry. EPA acknowledges that these newer designs may use both less refrigerant overall and refrigerants with lower-GWPs but disagrees that the leak repair requirements penalize food retailers that have switched to such equipment because these requirements apply equally to equipment subject to the requirements. Furthermore, the Agency has previously stated that the overall reduction in charge size the RACHP sector is part of EPA's rationale for lowering the charge size threshold to 15 pounds. Refrigerant-containing appliances between 15 and 50 pounds still contain HFCs and covered substitutes which have a detrimental effect on the environment. The extension of the leak repair requirements to capture refrigerant-containing appliances between 15 and 50 pounds will ensure that less HFCs are emitted. The Agency responds that the GreenChill partnership is a voluntary partnership program and does not require the supermarket industry as a whole or the partnership to meet specific leak repair requirements. Advancements in refrigerant charge sizes cannot solely be attributed to the GreenChill partnership as appliance manufacturers and supermarket owners had incentives to lower the charge size of supermarket systems to save on refrigerant costs and improve energy efficiency. The Agency, however, does recognize that supermarkets in the GreenChill voluntary partnership are uniquely positioned to meet the leak repair requirements as partners have been able to consistently achieve lower leak rates by adopting newer system technologies, using newer refrigerants, applying best practices, and maintaining leak tight systems to decrease refrigerant emissions. The Agency also disagrees with the commenters framing that the 15-pound threshold would disincentivize owners or operators from investing the refrigerant-containing appliances at lower charge sizes. Owners and operators may decide to transition to refrigerant-containing appliances with smaller charge sizes to save money on refrigerant costs and mitigate the potential of leakage characterized by refrigerant-containing appliances at larger charge sizes. EPA does not find that owners or operators would solely transition to appliances with small charge sizes to avoid leak repair requirements.

EPA also disagrees with one commenter's assertion that owners or operators who have recently transitioned to HFO systems will need to transition again. This final rule is not regulating the transition of refrigerant-containing appliances, rather, the final rule is establishing leak repair requirements for refrigerant-containing appliances with a charge size greater than 15 pounds which use an HFC or substitute for an HFC with a GWP greater than 53. EPA did not propose and is not finalizing requirements for refrigerant-containing appliances to transition or be replaced (unless a refrigerant-containing appliance is not able to be repaired and is subject to the retrofit or retirement requirements described in section IV.C.3.f of this preamble). The Agency views the leak repair requirements of the final rule to provide numerous benefits to owners or operators (*e.g.,* reduced costs to replace lost refrigerants due to leaks). As the commenter stated, HFC centralized systems if well maintained can be reliable and cost-effective for owners and operators and the leak repair requirements of the final rule ensure that these systems are well maintained. Further, owners or operators who are using HFOs or HFO blends are only subject to the leak repair requirements if the refrigerant used contains an HFC or has a GWP greater than 53. For these reasons, the Agency also disagrees that smaller facilities will transition to fan refrigeration systems in order to avoid the leak repair requirements of the final rule. EPA does not foresee fan systems as being a replacement to refrigerant-containing appliances that use HFCs and notes that there are non-HFC alternatives available for certain refrigerant-containing appliances used by the retail food industry.

EPA also disagrees that the leak repair requirements disproportionately impact owners or operators in states with higher heat indexes and limited alternatives. As stated previously, this rule is not requiring the transition to different alternatives or prohibiting the use of HFCs, rather, the rule is establishing requirements to ensure leaks in refrigerant-containing appliances containing HFCs or covered substitutes are repaired in a timely manner. The Agency understands that differences in ambient temperature will affect the need for RACHP appliances, however, the leak repair requirements apply equally to refrigerant-containing appliances regardless of geographic location. Furthermore, the prompt repair and management of refrigerant-containing appliances in states with higher heat indexes where RACHP is utilized more, will help save owners and operators costs associated with leaky appliances.

EPA is finalizing as proposed, the exemption of the residential and light commercial air conditioning and heat pump subsector[56] from the leak repair provisions in the final rule. This

[56] The residential and light commercial air conditioning subsector includes equipment for cooling air in individual rooms, single-family homes, and small commercial buildings, including both self-contained and split systems. Self-contained systems include some rooftop AC units (*e.g.*, those ducted to supply conditioned air to multiple spaces) and many types of room ACs, including packaged terminal air conditioners (PTACs), some rooftop AC units, window AC units, portable room AC units, and wall-mounted self-contained ACs, designed for use in a single room. Split systems include ducted and non-ducted mini-splits (which might also be designed for use in a single room),

subsector is categorized by refrigerant-containing appliances that are used to cool individual rooms, single-family homes, and small commercial buildings. The Agency notes that the description of the subsector is consistent with the description used by the SNAP program since 2009,[57] owners or operators should be familiar with the terminology and implementation under the SNAP program. EPA is not providing a regulatory definition of residential and light commercial air conditioning and heat pumps and clarifies that we are using the terminology developed by SNAP to denote the types of refrigerant-containing appliances that would be considered to fall under the subsector. The determination of whether or not a refrigerant-containing appliance is exempt from the leak repair provision is reliant on such appliances being considered to fall within the parameters of the terminology. As described in the proposal, the vast majority of refrigerant-containing appliances in the residential and light air conditioning subsector typically have a charge size of less than 15 pounds; however, EPA is providing an exemption in the case that an appliance is used within this subsector with a charge size of 15 pounds or more. These refrigerant-containing appliances are used in residences (but this subsector does not include larger centrally-cooled apartment/condominium buildings – where a chiller is likely used), and small retail and office buildings. The types of specific refrigerant-containing appliances used in this subsector could include but are not limited to:

- Packaged terminal air conditioners (PTACs);
- Variable refrigerant flow (VRF) appliances;

multi-splits and variable refrigerant flow (VRF) systems, and ducted unitary splits. For additional information on the types of equipment, see EPA's website at *https://www.epa.gov/snap/substitutes-residential-and-light-commercial-air-conditioning-and-heat-pumps*.

[57] This subsector was previously characterized as "household and light commercial air conditioning" (61 FR 4736, February 8, 1996). EPA later revised this subsector's name because it was recognized the "house" might be taken to exclude other types of dwellings, such as apartments.

- Unitary air conditioning; and
- Some rooftop air conditioning.

There are several reasons for this exemption. Since the majority of appliances in this subsector have a refrigerant charge below the 15-pound cutoff for leak repair requirements, enforcement of those these appliances may be challenging due to the number of appliances that would be covered. Further, the amount of refrigerant-containing appliances in this subsector may cause additional strain on contractors and technicians who are necessary to complete the repair of leaking appliances. Therefore, EPA 's exemption of appliances in this subsector from the leak repair requirements is administratively more efficient and will facilitate compliance of affected appliances under the provision.

Comment: EPA received generally positive comments on the exemption of residential and light commercial air conditioning with the majority of comments requesting clarity of what appliances are covered by the exemption. One commenter stated that codifying a definition for residential and light commercial air conditioning and heat pumps would avoid confusion in the regulated community. Two commenters requested EPA consider codifying the industry definition of light commercial defined as having a cooling capacity below 65,000 BTU/h. One commenter urged EPA to clarify what it considers a "small commercial building." One commenter stated that EPA should define residential and light commercial refrigeration to be consistent with how SNAP defines the residential and light commercial air conditioning and heat pump subsector. The commenter stated that a definition of light commercial air conditioning consistent with SNAP would exclude chillers but include most other forms of household and commercial cooling. Another commenter requested clarification on whether air conditioning systems for supermarkets would be classified as light commercial and therefore exempt from leak repair requirements. The commenter added that if EPA were to clarify that supermarket air conditioning appliances do not fall under light commercial air conditioning, the Agency would need to evaluate the significant cost burdens associated with the decision.

Response: EPA is finalizing the leak repair exemption of residential and light commercial air conditioning and heat pumps. The Agency acknowledges comments in support of the provision. In response to commenters' request that EPA better define residential and light commercial air conditioning and heat pumps the Agency has provided additional description and discussion in the preamble of this rule. EPA clarifies that it is not codifying a definition of the subsector nor is it adopting a 65,000 BTU/h industry standard as one commenter suggested, because we find the additional clarification of the subsector included in the preamble to be sufficient in alleviating potential confusion with what refrigerant-containing appliances are included in the residential and light commercial air conditioning and heat pumps subsector. The Agency reiterates that the majority of appliances subject to this narrow exemption are below the final rule's 15-pound charge size threshold for the leak repair provision. EPA notes that the terminology used for the residential and light commercial air conditioning and heat pumps sector mirrors the terminology created and implemented under the SNAP program under the CAA, which has been used in that context since 2009. As used in the context of SNAP, this residential and light commercial air conditioning and heat pumps end-use includes equipment that cools enclosed spaces in households and commercial premises (excluding chillers) which include room air conditioning such as window units, PTACs and heat pumps , and portable air conditioners; central air conditioners (*i.e.*, ducted); non-ducted systems (both mini and multi splits); packaged rooftop units; water-source and ground-source heat pumps; and other products. Residential and light commercial air conditioning and heat pumps are often distinguished from chillers by the fact that they condition the air directly, rather than cool (or heat) water that is then used to condition air.[58] The Agency intends for the term as used in the context of this rulemaking under subsection (h) to have the same meaning as it has under the SNAP program, given the Agency's experience in regulating this end-use under SNAP and its expectation that the regulated community is familiar with this term and its use under SNAP.

The SNAP terminology is based, in part, on ASHRAE's standard 15-2022 which provides more clarity of what types of occupant spaces that fall into the category of what EPA refers to as residential and light commercial. For "residential occupancy" some premises include but are not limited to dormitories, hotels, multiunit apartments, and private residences. For "commercial occupancy" some premises include office and professional buildings, markets, and other work or storage areas. EPA notes that ASHRAE standards are primarily addressing issues with safety in relation to "residential occupancy" or "commercial occupancy" whereas SNAP is addressing the safety and applicability of specific refrigerants which are determined as acceptable for use in specific end-uses. Further, while these descriptions of "residential occupancy" and "commercial occupancy" are helpful in the determination of the types of premises which may fall within the purview of residential and light commercial, the agency clarifies that the exemption applies to the categories of refrigerant-containing appliances used at these premises. In this final rule, EPA is using the types of refrigerant-containing appliances described under SNAP's terminology for residential and light commercial air conditioning and heat pumps to determine what refrigerant-containing appliances fall under the exemption. For example, a central air conditioner being used to provide cooling for occupants in a commercial

[58] SNAP Notice 23 (January 2, 2009; 74 FR 21)

setting that has the same shape, size, and cooling load as a refrigerant-containing appliance used in a residential setting would fall under this exemption. An air conditioning appliance at a light commercial building would most likely be a rooftop AC unit, which is one type of light commercial air conditioning.[59] In addition to rooftop AC units, other types of air conditioners and heat pumps are part of the residential and light commercial AC and HP subsector and hence are exempt from the leak repair requirements, such as single packaged units, split system central air conditioners and heat pumps, window-mounted air conditioners, through-the-wall units, and portable air conditioners. EPA clarifies that the exemption does not apply to a chiller, a type of air conditioning system that is often used to provide comfort cooling to office buildings, malls, stadiums, arenas, hotels, convention centers, airport terminals, etc.

In response to the question regarding supermarket air conditioning, the Agency clarifies that some but not all supermarket air conditioning systems would fall under the definition of residential and light commercial air conditioning based on the refrigerant-containing appliance being used to cool occupants. However, if a supermarket refrigeration rack is providing comfort cooling as well as refrigeration for perishable foods, it would not be exempt from the leak repair requirements (unless it contained less than 15 pounds of a regulated HFC or HFC substitute with a GWP greater than 53) because this type of refrigerant-containing appliance does not fall under the terminology of residential and light commercial AC and HP. With regards to the assertion

[59] The Technology Transitions Rule describes rooftop AC units as products that combine the compressor, condenser, evaporator, and a fan for ventilation in a single package and may contain additional components for filtration and dehumidification. Most units also include dampers to control air intake. Rooftop AC units cool or heat outside air that is then delivered to the space directly through the ceiling or through a duct network. Rooftop AC units are common in small commercial buildings such as a single store in a mall with no indoor passageways between stores. They can also be set up in an array to provide cooling or heating throughout a larger commercial establishment such as a department store or supermarket. *https://www.federalregister.gov/d/2023-22529/p-903*

that there are significant costs if not all supermarket air conditioning systems were exempt from the leak repair requirements, EPA refers the reader to the RIA TSD.

Comment: A few commenters suggested that residential and light commercial air conditioning and heat pump systems should not receive an exemption from leak repair requirements. Several commenters specifically called out the need to include VRF systems under the leak repair provision. One commenter highlighted that multi-split RACHP and VRF systems can contain large refrigerant charges, have many points of potential leakage, and may be more limited in regard to low-GWP alternatives. Another commenter requested that commercial rooftop systems with a charge size above five pounds be covered under the leak repair provision. The commenter agreed with the Agency's decision to exclude residential systems but encouraged EPA to establish leak repair requirements for light commercial air conditioning and heat pumps. A separate commenter in support of the exemption suggested that the Agency could revisit the leak repair exemption for residential air conditioning and heat pump systems at a future date as leak detection solutions become available and cost effective for these systems.

Response: EPA disagrees with comments requesting that the exemption for residential and light commercial air conditioning not be finalized. In the context of the 608 ODS regulations, residential and light commercial air conditioning were not anticipated to be affected by the leak repair provisions because of the regulation's 50-pound charge size threshold. Under the authority of the AIM Act, EPA sought to align with the 608 regulations where appropriate and to lower the charge size threshold to 15 pounds for reasons as further discussed in section IV.C.1 of the preamble. In the proposed rule, EPA recognized that a lower leak repair charge size threshold might implicate appliances that are used in the residential and light commercial air conditioning subsector that were not previously subject to leak repair requirements. The Agency notes that the inclusion of refrigerant-containing appliances would greatly expand the number of refrigerant-containing appliances subject to the leak repair requirements and may make the enforcement of the leak repair provisions inefficient. While a portion of the refrigerant-containing appliances used in the residential air conditioning subsector may have charge sizes above 15 pounds, the Agency found it prudent to not require wide breadth of leak repair for this category of appliances in the final rule. The Agency also notes that the specific exclusion of residential air conditioning may ease implementation for this first rule under subsection (h). With a similar reasoning, the Agency notes similar concerns would arise from making appliances commonly used in light commercial air conditioning (*e.g.*, central air conditioners, rooftop AC units, etc.) adhere to the leak repair requirements. For these reasons the Agency disagrees with one commenter's recommendation to apply the leak repair requirements to light commercial rooftop systems with a charge size greater than five pounds. As one commenter indicated, leak detection could be less costly in the future. The Agency agrees it could, in a future notice-and-comment rulemaking, reconsider the leak repair exemption for residential and light commercial air conditioning and heat pumps.

While EPA agrees that VRF appliances could have higher refrigerant charge sizes, the Agency disagrees that VRF appliances should be excluded from the exemption for leak repair as VRF is a general term describing a type of appliance which is included in the description of the residential and light commercial air conditioning and heat pumps subsector. VRF appliances are refrigerant-containing appliances that can handle differentiated loads. EPA is using the SNAP terminology to determine the categories of refrigerant-containing appliances that are exempt from the leak repair provision; VRF appliances have been considered to be part of that SNAP terminology. In the 2023 Technology Transitions Rule, VRF appliances above 65,000 BTU/h were split off from the residential and light commercial AC and HP subsector, and defined as its own subsector, in part because of the complexity of the design and installation of larger VRF systems. The additional year was given to ensure the effective transition to lower-GWP alternatives in the subsector. Further, annual industry estimates by AHRI[60] show that refrigerant-containing appliances with capacitates of 65,000 BTU/h or more constitute roughly three percent of all residential and light commercial refrigerant-containing appliances sold. VRF appliances of this size are a subset of this three percent. Additionally, EPA did not propose and is not finalizing to separate VRF appliances from the leak repair exemption for the residential and light commercial AC and HP subsector. EPA in a future notice-and-comment rulemaking may reconsider the inclusion of certain VRF appliances which currently are exempt from the leak repair requirements of this final rule.

The Agency is requiring leak repair provisions for new and existing passenger buses,[61,] including school, coach, transit, and trolley buses with charge sizes at or above 15 pounds. The heavy-duty vehicle category[62] incorporates all motor vehicles with a gross vehicle weight rating of 8,500 pounds or greater. Air conditioning systems used to cool passenger compartments in these buses mainly use HFC-134a or R-407C,[63] and are typically manufactured as a separate unit that is pre-charged with refrigerant and installed onto the vehicle in a separate enclosure (*e.g.*, roof mounted). The refrigerant charge for these systems is larger than those for other MVAC systems (*e.g.*, light-duty motor vehicles), typically ranging from 15 to 30 pounds. MVAC

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[60] AHRI 2024; available at: *https://www.ahrinet.org/analytics/statistics/historical-data/central-air-conditioners-and-air-source-heat-pumps*

[61] "Bus" is defined at 40 CFR 1037.801 and means "a heavy-duty vehicle designed to carry more than 15 passengers. Buses may include coach buses, school buses, and urban transit buses."

[62] Defined at 40 CFR 86.1803-01.

[63] Chemours, Freon ™ Refrigerant for Bus and Rail Air Conditioning; available at: *https://www.freon.com/en/industries/stationary-ac-heat-pumps/public-transport-ac*.

systems used to cool passenger compartments in light-duty, medium-duty, heavy-duty on-road and nonroad (off-road) vehicles are typically charged during vehicle manufacture and the main components are connected by flexible refrigerant lines. MVAC systems in these vehicles typically have charge sizes ranging from one to eight pounds depending on the manufacturer and cab size.[64, 65]

Comment: One commenter expressed support for EPA's inclusion of MVAC systems with charge sizes over 15 pounds in the leak repair provisions. The commenter argued that these MVAC systems, such as those on buses and trains, may lose large amounts of refrigerant over time.

Response: EPA acknowledges the commenter's support for and is finalizing the requirement for MVAC and MVAC-like appliances.

Comment: A commenter questioned the authority of EPA to regulate the commercial aviation sector, including refrigerant-containing appliances aboard aircraft and at airports and hangars. The commenter stated that the Federal Aviation Administration (FAA) has the authority and responsibility to ensure such requirements do not adversely affect efficient operation and aircraft safety. The commenter asserted that EPA has not coordinated with the FAA regarding the potential application of the rule's requirements. Additionally, the commenter stated that the proposed rule lacked clarity regarding how the rule would apply to the commercial aircraft sector and questioned why the rule did not exempt the commercial aviation sector from the leak repair

[64] ICF, 2016. Technical Support Document for Acceptability Listing of HFO-1234yf for Motor Vehicle Air Conditioning in Limited Heavy-Duty Applications. Available at: *https://www.regulations.gov/document/EPA-HQ-OAR-2015-0663-0007*.

[65] EPA, 2021. Basic Information about the Emission Standards Reference Guide for On-road and Nonroad Vehicles and Engines. Available at *https://www.epa.gov/emission-standards-reference-guide/basic-information-about-emission-standards-reference-guide-road*.

and ALD requirements. Lastly, the commenter stated the proposed rule did not provide sufficient time for the sector to safely comply with the rule's leak repair requirements and specified that EPA must extend the applicable leak repair compliance deadlines for commercial aircraft.

Response: EPA disagrees with the commenter's broad assertion that EPA does not have the authority to issue regulations pertaining to aircraft and aircraft operations. While EPA agrees that the FAA has jurisdiction over matters related to aircraft safety and operations consistent with its Congressionally mandated authorities, under CAA Title VI and the AIM Act, EPA has issued numerous regulations that concern the use of ODS and HFCs in many applications including onboard aviation and flight operations. With respect to this action, the AIM Act does not exclude aircraft or aircraft operations from the scope of implementing regulations. Notably, the inclusion in the statute at 40 CFR 84.3 of "onboard aerospace fire suppression" which includes aircraft,[66] indicates that Congress did not intend to exempt aircraft and aircraft operations from the AIM Act. In addition, the commenter does not address the provisions of subsection (h) itself. None of the text of subsection (h) indicates that Congress contemplated that these provisions would not apply to equipment used in commercial aviation. Congress expressly addressed inapplicability of regulations under (h) in subsection (h)(4), in which it provided that regulations under subsection (h) shall not apply to HFCs or their substitutes contained in foams. If Congress had intended to exclude equipment used in commercial aviation from regulations promulgated under subsection (h), it would be reasonable to expect that the statute would include similar language creating that

[66] EPA's regulations at 40 CFR 84.3 define on board aerospace fire suppression to mean "use of a regulated substance in fire suppression equipment used on board commercial and general aviation aircraft, including commercial-derivative aircraft for military use; rotorcraft; and space vehicles. On board commercial aviation fire suppression systems are installed throughout mainline and regional passenger and freighter aircraft, including engine nacelles, auxiliary power units (APUs), lavatory trash receptacles, baggage/crew compartments, and handheld extinguishers."

exclusion. Although the comments do not appear to base their objections on the text of subsection (h), to the extent they intend to claim that this rulemaking exceeds EPA's authority under that provision, EPA notes that it is establishing the subsection (h) requirements in this final action to control practices, processes, or activities regarding the servicing, repair, disposal, or installation of equipment that involves a regulated substance or a substitute for a regulated substance and to serve the statutory purposes identified in subsection (h). Thus, this final action is within the scope of EPA's authority under subsection (h)(1), including as it pertains to equipment used in commercial aviation.

With respect to the commenters' assertions that finalizing the proposed rule would conflict with the Federal Aviation Act's statutory purpose and scheme and that this statute reserves to the FAA jurisdiction over matters related to aircraft safety and operations and broadly preempts the field of regulation with respect to commercial aviation, aircraft operations, and aircraft safety, EPA responds that the information presented in the comment letter does not indicate that EPA is generally precluded from including requirements related to the commercial aviation sector in this rulemaking. The comment cites and quotes cases that speak to the pervasive nature of federal regulation in this area and address the preemption of state and local regulations. However, preemption of state and local laws is not relevant to EPA's authority to establish regulations under the AIM Act.

In response to the commenter's assertions that EPA should consult with the FAA on these regulations, particularly for any leak repair requirements that may apply to the commercial aviation sector, the Agency communicated with FAA as with other federal agencies, to better inform rulemaking under the AIM Act. The Agency also notes that these leak repair provisions mostly align with the regulations under CAA section 608. For decades these rules have applied to the refrigeration and air conditioning appliances at airports and within aircraft hangers, and the Agency has considered commercial aircraft to be non-MVAC appliances covered under CAA section 608. The Agency also disagrees with the commenter's argument that owners and operators in the commercial aviation sector do not have enough time to safely comply with the provision. EPA notes that the 30-day timeframe timeline for repairs is the same as in the CAA section 608 rules, which does not exempt the commercial aviation sector. The leak repair provisions also provide owners or operators the ability to submit extension requests if some unforeseen circumstances (*e.g.,* necessary components to complete leak repair are unavailable during the 30-day leak repair timeframe) prohibit an owner or operator from completing leak repair within the normal 30-day timeframe. Moreover, the comment also did not provide substantive evidence as to why aircraft owners and operators would not be able to safely comply with the leak repair provisions, nor did the commenter identify any information that suggests that these requirements would adversely affect the proper functioning of aircraft air conditioning.

Finally, EPA notes that the 2023 Technology Transitions Rule provided a temporary exclusion to onboard galley refrigeration on aircraft due to their unique operating environment and the fact that these units are subject to FAA's design and installation requirements under 40 CFR 25.1365. The Agency clarified the intention to revisit this application through a notice-and-comment rulemaking no later than five years after the compliance date for retail food refrigeration-stand-alone units—*i.e.*, no later than January 1, 2030. The temporary exclusion for this specific application was given in the context of subsection (i) and the transition of sectors and subsectors to lower-GWP alternatives. However as previously discussed elsewhere, the criteria and purposes of subsection (i) and (h) are different. This rulemaking is finalizing leak repair requirements for the purposes of minimizing the release of regulated substances from equipment and maximizing the reclamation of regulated substances. The repair of leaks does not have the same implications for the design and installation of refrigerant-containing appliances as restrictions on the use of higher-GWP HFC refrigerants. The Agency also notes that the exemption for onboard galley refrigeration does not extend to ground-based appliances used by the commercial aviation industry because maintenance and ground operations are not subject to the same FAA requirements as onboard galley refrigeration. Likewise, the repair of leaks in appliances used in ground and maintenance operations (*e.g.*, aircraft hangers) are not exempt from the leak repair requirements in this final rule, nor are they out of the scope of EPA's authority to regulate appliances at airports or aboard aircraft. With these considerations EPA finds it appropriate to apply the leak repair requirements to the commercial aviation sector.

The Agency is finalizing a compliance date of January 1, 2026, for all appliances with charge sizes of 15 pounds or more of a refrigerant containing an HFC or a substitute for an HFC with a GWP above 53, including for such appliances with a charge size of 50 pounds or more, which is a modification from the proposal. In the proposal, the Agency proposed a compliance date of 60 days from publication in the **Federal Register** for appliances with a charge size above 50 pounds and a compliance date of one year from the final rule's publication in the **Federal Register** for appliances with a charge size between 15 and 50 pounds. EPA reasoned that the compliance date for appliances above 50 pounds could be sooner because the leak repair provisions in the final rule are similar to those that have been in place, for some time, for ODS-containing appliances at or above a full charge size of 50 pounds. Further, prior to the rescission in 2020 (85 FR 14150, March 11, 2020), the final rulemaking under CAA section 608 in 2016 (81 FR 82272, November 18, 2016) applied leak repair provisions for HFC-containing appliances with a charge size of 50 pounds or greater. The 2016 CAA Section 608 Rule became effective on January 1, 2017, and the relevant leak repair requirements for HFCs and other ODS substitutes (now rescinded) applied as of January 1, 2019 (81 FR 82272, 82356, November 18, 2016). Thus, the Agency reasoned that industry was, at a minimum, familiar with the leak repair provisions under CAA section 608, which are similar to the leak repair requirements established under subsection (h) in this action. In regard to refrigerant-containing appliances with a full charge that is at least 15 pounds but less than 50 pounds, the proposal included a slightly longer compliance timeline, as EPA had not previously required leak repair for these appliances. The additional time was intended to allow the regulated community time to familiarize themselves with the requirements and make preparations to comply with them.

Based on further consideration and information provided by commenters, EPA is finalizing a single compliance date, January 1, 2026, to provide owners and operators additional time to comply with the leak repair provisions in the final rule. EPA concludes that this additional time will allow parts of the regulated community that may not have previously had to comply with the leak repair requirements under CAA section 608 time to familiarize themselves with the provisions. While EPA still finds, as at proposal, that parts of the regulated community are already familiar with the requirements based on their experience with similar requirements under CAA section 608, EPA concludes that they would also benefit from additional time to prepare for compliance. During the interim period before the leak repair requirements go into effect, owners or operators can begin determining which refrigerant-containing appliances within a facility will be subject to the leak repair requirements, including conducting inventories, determining the refrigerants used within said appliances, and determining the full charge of refrigerant-containing appliances in their ownership. EPA does not expect this process to take an exceptional amount of time; however, the extension to the compliance date is being provided to ensure owners and operators can complete the necessary steps to prepare for the leak repair requirements, consistent with this final rule.

Comment: The Agency received mixed comments on the proposed compliance date for the leak repair provisions with the majority of comments asking EPA to re-evaluate the proposed timeline and provide additional time to comply with the leak repair requirements. Commenters suggested a longer period to allow manufacturers, facility owners and operators, and other stakeholders sufficient time to prepare for the regulations. Suggested compliance timelines ranged from an additional one to three years, with some commenters suggesting staggered compliance timelines based on charge size. One commenter stated that a compliance date after three years from the rule's finalization would be needed for stakeholders to plan, procure, and implement the leak detection and repair requirements. Another commenter suggested a compliance date two years after finalization so that owners and operators of smaller equipment who may have not previously experienced leak repair requirements could design, procure, set up, and implement a refrigerant management program.

One commenter in support of the proposed compliance date noted that California has had similar requirements for appliances using more than 50 pounds of HFC refrigerants since 2011, highlighting that nationwide appliances using more than 50 pounds of ODS refrigerants have had similar rules for several years. Another commenter suggested both appliance categories (*i.e.*, 50 pounds and greater, and 15 to 50 pounds) should have the same compliance date of one year after the date of the final rule. The commenter also argued that appliances with a charge size of above 50 pounds that are using 100 percent substitute refrigerants will need additional time to conduct inventory, determine the applicability of appliances using substitute refrigerants, and determine the full charge of appliances. The commenter suggested that this strategy would avoid market confusion by having multiple compliance dates. One commenter, in general support of the leak repair provision, stated the proposal's compliance timeline presumes that the regulated community is familiar with the leak repair provision promulgated under the CAA. The commenter stated that a number of new facility owners or operators have little to no experience with the CAA section 608 regulations and requirements.

Response: Based on further consideration and informed by the comments, the Agency is finalizing a single compliance date, rather than two dates for leak repair for appliances with a charge size of 15 pounds or more. The Agency is providing additional time from what was proposed in both instances. EPA disagrees that the staggered compliance date in the proposal would have created market confusion, as the Agency has previously implemented staggered compliance dates for a number of reasons. For example, the ALD provision in this final rule has a staggered compliance date for new and existing IPR and commercial refrigeration systems above 1,500 pounds to ensure, among other considerations, that adequate supply is available for owners and operators to comply with this provision. Regardless, EPA has aligned the compliance date for the leak repair provision so any confusion with complying with the provision has been attenuated.

The Agency agrees additional time may be necessary for the owners and operators to prepare to comply with the leak repair provisions in this final rule, specifically for owners or operators that may not have been subject to the CAA section 608 requirements during the three-year period described in this section. The Agency disagrees with one commenter's claim that new facility owners would not be aware of the leak repair provisions under the CAA. Before the rescission of the CAA section 608 requirements in 2020, facility owners using appliances containing ODS substitutes (*e.g.*, HFCs) would have been subject to the leak repair requirements under the CAA for three years. The Agency also notes that not all portions of the 2016 CAA Section 608 Rule were rescinded in the 2020 rule. For example, owners and operators utilizing ODS substitutes, including HFCs, are subject to the venting prohibition (40 CFR 82.154). Thus, owners or operators now subject to the leak repair provisions in this rule should be well acquainted with similar requirements under CAA part 82, subpart F or at a minimum, generally aware of the leak repair requirements under CAA part 82, subpart F. While EPA disagrees generally that newer facility owners are not aware of previous requirements for HFCs or requirements for ODS, to the extent this is true, the Agency provided notice in the proposal with regards to the potential to finalize leak repair requirements for refrigerant-containing appliances containing HFCs and HFC substitutes with a GWP above 53 and is finalizing a later compliance date allowing more time for owners and operators to familiarize themselves with the requirements.

The Agency disagrees that compliance dates beyond January 1, 2026 (*e.g.*, 18 months, two years, three years), are needed in order for owners or operators to comply with the leak repair provision. EPA determined that one year should be sufficient to prepare for the leak repair provision. As discussed previously, the leak repair requirements, aside from the charge size threshold and the limited ALD installation requirements, are mostly aligned with the leak repair requirements for ODS under the CAA. Further, the Agency finds the timing of the compliance date to be appropriate, considering the phasedown of HFCs, and does not find it appropriate to delay leak repair of refrigerant-containing appliances that serve the purposes described in subsection (h)(1). Commenters stated that owners and operators need time to plan, procure, and implement the leak repair and detection requirements; however, the commenters did not provide analysis to show that owners and operators would not be able to comply with the leak repair provisions by January 1, 2026, or why any of the longer time frames suggested by commenters would be necessary for compliance. For similar reasons, EPA disagrees with commenters requesting additional time and staggered compliance dates based on charge size. The Agency understands that to some extent, owners and operators may need to conduct inventories of refrigerant-containing appliances under their ownership and determine which appliances are subject to the leak repair provision (*i.e.*, applicability of refrigerant-containing appliances in regard to charge size and refrigerant being used). The Agency does not view this process to take an exceptional amount of time, as owners or operators should be aware of the full charge and type of refrigerant contained in an appliance from previous service records or manufacturer specifications for the refrigerant-containing appliance. The Agency refers owners or operators to section IV.A.1 of this preamble, if they require guidance, for determining the full charge of refrigerant-containing appliances. The Agency also refers owners or operators to section IV.C.1 of this preamble, for further information, regarding the applicability of HFC substitutes to the leak repair requirements in this final rule. Owners or operators have over a year to determine which refrigerant-containing appliances are subject to the leak repair requirements and resolve any uncertainty concerning the applicability of the refrigerant-containing appliances in their ownership.

3. What leak repair provisions is EPA establishing?

EPA is finalizing the leak repair requirements under subsection (h) as proposed. These requirements are part of implementing subsection (h)(1) of the AIM Act, as these provisions control practices, processes, or activities regarding servicing or repair of refrigerant-containing appliances, which are a type of equipment, and involve a regulated substance or a substitute for a regulated substance with a GWP greater than 53. As described in section IV.C.2 of this preamble, these leak repair requirements apply to refrigerant-containing appliances with a charge size of 15 pounds or more where the refrigerant contains an HFC or a substitute for an HFC with a GWP greater than 53. The leak repair provisions finalized in this rule will require action if such a refrigerant-containing appliance has been determined to be leaking above the applicable leak rate threshold, pursuant to the regulations. While most of the actions required under the leak repair provisions are triggered by the determination that the refrigerant-containing appliance has leaked above the applicable leak rate threshold, the leak rate calculations and certain recordkeeping requirements apply to refrigerant-containing appliances that are not leaking above the threshold. While EPA is adopting the same applicable leak rates for the leak repair requirements under subsection (h) as applies under 40 CFR 82.157, as described in section IV.C.3.b of this preamble, EPA is also establishing certain provisions that are different from those included in 40 CFR 82.157, that support identifying and potentially repairing leaks sooner (see section IV.D.1 of this preamble for requirements for ALD systems).

In the proposal, EPA reviewed the regulations promulgated under CAA section 608, as codified in 40 CFR part 82, subpart F, addressing the same or similar practices, processes, or activities as addressed in this rulemaking to consider the extent appropriate to coordinate requirements in those regulations with those in this action. Specifically, EPA reviewed the leak repair requirements at 40 CFR 82.157, which do not apply to appliances containing HFCs or their substitutes. The leak repair provisions under CAA section 608 contain requirements for practices, processes, and activities related to identifying and repairing leaks in appliances that contain ODS. As discussed further in this section, EPA concludes that it is appropriate to apply these practices, processes, and activities to appliances containing HFCs and certain substitutes for HFCs under subsection (h). EPA notes that in many cases, the same types of appliances (*e.g.*, chillers, rooftop air conditioning units, supermarket systems) are used, since HFCs are substitutes for ODS. EPA did not propose and is not finalizing new requirements in this action where the provisions in 40 CFR part 82, subpart F already apply to appliances containing HFCs and certain substitutes.

The following subsections provide additional information on the leak repair requirements established by this final rule. Section IV.C.3.a. of this preamble provides information on leak rate calculations, which are required whenever refrigerant is added to a refrigerant-containing appliance. The Agency allows owners or operators to use one of two leak rate calculation methodologies to determine the leak rate of a refrigerant-containing appliance and whether repair is required. Section IV.C.3.b. of this preamble describes the timeline for leak repair, requests for leak repair extensions, and applicable leak rate thresholds for refrigerant-containing appliances. The exceedance of a refrigerant-containing appliance's leak rate threshold triggers the leak repair requirements of this final rule. Section IV.C.3.c of this preamble provides information on verification testing, which is necessary to determine that the repair of a leaking refrigerant-containing appliance has not failed. Section IV.C.3.d. of this preamble describes the timeline for quarterly and annual leak inspections for appliances that have passed the follow-up verification tests described in section IV.C.3. Leak inspections of recently repaired refrigerant-containing appliances ensure that repairs hold and assist in determining if further repair action is required in the event a repair fails. Section IV.C.3.e. of this preamble provides information on chronically leaking appliances, which are subject to specific reporting requirements if a refrigerant-containing appliance expends more than 125 percent of its full charge within a year. Section IV.C.3.f. of this preamble describes the process of submitting retrofit or retirement plans to the Agency in the event a refrigerant-containing appliance cannot be repaired within the leak repair timeframe discussed in section IV.C.3. Finally, section IV.C.3.g. of this preamble describes recordkeeping and reporting requirements for owners or operators subject to the leak repair requirements of this final rule.

Comment: Several commenters in support of the leak repair and detection requirements supported the Agency's efforts to regulate HFCs, as these requirements broadly enhance activities and practices that further lifecycle refrigerant management (LRM). One of the commenters stated that leak prevention is a cornerstone of LRM and stated that the Agency has clear authority under the AIM Act to promulgate robust leak prevention regulations that support LRM.

Response: EPA acknowledges commenters' support for the leak repair and detection requirements in the final rule. While the Agency did not base this rule or its provisions on lifecycle management, EPA agrees that the leak repair and ALD requirements will reduce the severity of leak events, minimizing refrigerant lost. These requirements and other refrigeration management best practices as a part of larger refrigerant management frameworks are important to EPA's implementation of this final rule to serve the purposes described in subsection (h)(1) of minimizing the release of regulated substances. The Agency also agrees that it has the authority under the AIM Act to regulate HFCs and limit their release through the leak repair and ALD requirements in this final rule.

a. Leak rate calculations

EPA is adopting the requirements for leak rate calculations under subsection (h) as proposed. Thus, refrigerant-containing appliances with a charge size of 15 pounds or more of a refrigerant that contains an HFC or a substitute for an HFC with a GWP above 53 are required to conduct a leak rate calculation if the appliance is found to be leaking. EPA is also requiring that the leak rate of covered appliances be calculated every time refrigerant is added to an appliance, unless the addition is made immediately following a retrofit, installation of a new appliance, or qualifies as a seasonal variance, as described in this and subsequent sections. EPA is not requiring the repair of all leaks; rather, EPA is requiring repair of leaks such that the appliance is below the applicable leak rate threshold consistent with the requirements at 40 CFR 82.157. The calculation of the leak rate is used to determine whether the appliance is leaking above the applicable threshold, which in turn determines whether further action (*i.e.*, repair) is required. For example, if an appliance owner adds refrigerant to the appliance but does not calculate the leak rate, the owner would have no means of determining if the appliance's leak rate was below the applicable leak rate threshold. Hence, the owner would not know if further action was warranted. Thus, the leak rate calculations are also used to determine compliance with the leak repair requirements. As stated in the proposal, this rulemaking's approach can contribute to minimizing the releases of HFCs or their substitutes by requiring more thorough leak inspections and verified repairs sooner.

In this final rule, the Agency is establishing two leak rate calculation methodologies: the annualizing method and the rolling average method. The utilization of leak rate calculation methodologies is analogous to their use under subpart F. The strength of the annualizing method is that it is future oriented and allows the owner or operator to "close out" each leak event so long as the requirements are followed and does not lump past leak events with the current leak event. It considers the amount of time since the last addition of refrigerant and then scales that up to provide a leak rate that projects the amount of refrigerant lost over a whole year if the leak is not fixed. As a result, this formula will yield a higher leak rate for smaller leaks if the amount of time since the last repair was shorter. The rolling average method also has its strengths. It accounts for all refrigerant additions over the past 365 days or since the last successful follow-up verification test showing that all identified leaks were successfully repaired (if less than 365 days). If an owner or operator verifies all identified leaks are repaired, this method allows an owner or operator to "close out" a leak event. If there is no follow-up verification test showing that all identified leaks were successfully repaired within the last year, the leak rate would be based completely on actual leaks in the past year. Owners and operators are provided the flexibility to choose which methodology is most advantageous to their operations. However, this action requires that once a methodology is chosen, the owner or operator must continue using the same methodology, so leak rate calculations remain consistent. This action also requires that owners or operators use the same leak rate calculation methodologies for all affected appliances at a facility. The two methods use two different paradigms to determine leak rate – one is forward-looking/predictive, while the other is backward-looking/retrospective. If an owner or operator were to switch between methods, they would not get an accurate calculation because the time frame being evaluated would be different for each method. In either methodology, EPA is establishing that when calculating the leak rate, any purged refrigerant that is destroyed is not counted towards the leak rate. To qualify for this exemption, the purged refrigerant must be destroyed at a verifiable destruction efficiency of 98 percent or greater.

EPA is allowing a narrow exception for owners or operators to change their leak rate calculation method in the final rule. There may be some cases, such as change of ownership, where an owner or operator may need to change the leak rate calculation method so that all facilities under their ownership are using the same method. EPA views this alignment of the leak rate calculation methodologies across facilities as valuable to consistent management of refrigerant-containing appliances across multiple facilities. In order for an owner or operator to make this change in leak rate calculation, the owner or operator must meet two conditions. First, the owner or operator must have recently purchased a new facility with a refrigerant-containing appliance that was using a different leak rate calculation method than the current leak rate calculation method used by the owner or operator. Second, the owner or operator must ensure the refrigerant-containing appliances at the purchased facility are leaking below the applicable leak rate when the leak rate is calculated using both methodologies. If the leak rate calculation is changed, the owner or operator is required to document why the change was made, the date the change was made, and that the new leak rate calculation methodology is used consistent with the record keeping requirements in 40 CFR 84.106(l)(3). EPA clarifies that an owner or operator cannot change their leak rate calculation if it results in the avoidance of leak repair (*e.g.*, if an appliance would be over the leak rate threshold using one method and below the threshold using the other method).

Lastly, EPA acknowledges that the leak rate calculation requires prior records in order to calculate the leak rate. Since owners or operators are not required to keep records of additions of refrigerants to an appliance prior to January 1, 2026, owners or operators may calculate leak rates for appliances containing an HFC or HFC substitute with a GWP greater than 53 as though there were no additions prior to that date. For example, if an owner or operator is using the annualizing method for the first addition of refrigerant in calendar year 2026, the second term would be 365/365 (or “1”). For subsequent additions the second term would be 365 divided by the shorter of the number of days since refrigerant was last added or 365. Alternatively, if an owner or operator is using the rolling average method, for the first addition of refrigerant in calendar year 2026, the numerator would be the pounds of refrigerant added since the shorter of January 1, 2026, or the last successful follow-up verification test, if one was conducted in 2026.

For subsequent additions the numerator would be the pounds of refrigerant added since the shorter of 365 days or the last successful follow-up verification test. The Agency clarifies that this method of calculating the leak rate is only allowed when previous records are absent. After the effective date of this provision and the first calculation of an appliance's leak rate, the owner or operator must use the shorter number of days since refrigerant is added or 365 days for subsequent leak rate calculations.

Comment: The Agency received comments in support of the proposed requirements and its alignment with the leak rate calculations under 40 CFR part 82, subpart F. One of the commenters requested that the Agency allow a facility to move from the annualizing method to the rolling average method for appliances regulated under 40 CFR part 82, subpart F, and 40 CFR part 84, subpart C, which is what EPA assumes the commenter intended to cite. The commenter claims that facility owners that had been using the annualizing method prior to the 2016 CAA Section 608 Rule continued to use that method due to the lack of compliance assistance and unknowns regarding technicians' ability to consistently document leak inspections. The commenter suggests that EPA could allow an appliance that has not experienced a leak event in over a year to move to a different leak calculation method.

Response: The Agency acknowledges comments in support of the provision. In response to one commenter's request to allow facility owners to change their leak rate calculation methodology for appliances regulated under 40 CFR part 82, subpart F, and 40 CFR part 84, subpart C, EPA notes that comments related to requirements under 40 CFR part 82, subpart F are outside the scope of this rulemaking and thus require no response. To the extent that the comment pertains to appliances subject to requirements to calculate leak rates under this action, the Agency requires that once a leak rate calculation has been chosen, a facility owner cannot switch to the other method. The leak rate calculation methods use different paradigms to calculate a leak rate, and switching between the two methods would not provide the facility owner with an accurate leak rate calculation. Furthermore, allowing an owner or operator to freely switch between leak calculation methods incentivizes non-compliance with the leak repair requirements in this final rule. As discussed in this section, the two leak rate calculation methodologies are using different time frames (*i.e.*, the annualizing method is prospective, and the rolling average method is retrospective) so switching between the two methods would create inconsistencies.

The Agency is providing a narrow exception for owners or operators to switch their leak rate calculation method in the event of a change in ownership if two conditions are met. First, an owner or operator must have recently purchased a separate facility that was using a different leak rate calculation method than the method currently used by the purchaser. Second, the owner or operator must ensure that all refrigerant-containing appliances at their facilities are leaking below the applicable leak rate thresholds for said appliances when the leak rate is calculated using both methods. For example, if one supermarket were to purchase another supermarket that was using a different leak rate calculation than the purchaser, the owner or operator may change the leak rate calculation method to ensure that all appliances at their facilities are using the same leak rate calculation. The owner or operator must ensure that refrigerant-containing appliances at both facilities are leaking below the applicable leak rate threshold when calculating the leak rate using both methods and must document and keep a record of this change. Records of this change must be kept in accordance with 40 CFR 84.106(l)(3). EPA clarifies that an owner or operator may not change their leak rate calculation if it results in the avoidance of leak repair (*e.g.*, if an appliance would be over the leak rate threshold using one method and below it using the other method).

Comment: One commenter did not support the leak rate methodologies in the proposed rule. One commenter stated the methodologies were unduly complicated and resource-intensive and pose significant challenges for companies that have multiple sites with appliances subject to these requirements. The commenter's perspective on the rule led them to believe that each leak must be documented separately, with its own verification test. The commenter further asserted that it would be impossible to know how much refrigerant was lost for each leak and that finalizing the proposed methods would thus be arbitrary and capricious. This commenter suggested that EPA could greatly simplify compliance by allowing owners and operators to calculate leak rates (and by setting compliance obligation triggers) based upon the percentage of total full charge that an appliance has leaked, cumulatively, during a calendar year. The commenter incorrectly stated that this calculation would mirror the process that owners or operators use to calculate whether an appliance is above the 125 percent threshold for chronically leaking appliances. The commenter also requested clarification on the leak calculation if there are two simultaneous leaks.

Response: EPA is finalizing use of the methodologies for leak rate calculations as proposed. The Agency notes that the later compliance date as compared with the proposal should provide time for owners and operators that were not subject to the ODS requirements to familiarize themselves with the leak calculation methods. The Agency disagrees with the commenter's assertion that the methodologies are overly burdensome or complicated. The leak rate calculation methodologies are identical to the requirements in the CAA section 608 regulations that have been successfully used for nearly 30 years (see 1995 CAA Section 608 Rule; 60 FR 40420, August 9, 1995). EPA is providing owners and operators flexibility by allowing them to use either methodology for a facility, and therefore, the owner and operator can select whichever they judge optimal for their specific appliances.

EPA disagrees with the commenter's recommended leak calculation method because the annual calculation of a leak rate would allow for refrigerant to be added throughout the year without the determination of a leak rate. The final rule's basis for leak repair is the determination of whether a leaking appliance has exceeded its applicable leak rate when refrigerant has been added to the appliance, as described in section IV.C.3.b. of this preamble. The commenter's proposed method would allow for the unmitigated release of refrigerant in between leak rate calculations and would not achieve the final rule's purpose of minimizing the release of refrigerants from appliances. Further, EPA clarifies that the separate provision for chronically leaking appliances does not mirror the leak calculation provision and does not serve the purpose of ensuring appliances leaking above the applicable leak rate threshold are repaired. As further explained in section IV.C.3.e, of this preamble, owners and operators of a chronically leaking appliance (an appliance that leaks more than 125 percent of its full charge in one year) are required to submit an annual report describing the efforts to identify leaks and repair the chronically leaking appliance. This provision is intended to provide information to EPA and further support efforts to minimize releases from chronically leaking appliances, not to determine when appliance repair is required.

EPA also disagrees with the commenter's argument that the final rule's leak rate calculation methodologies are arbitrary and capricious. This comment appears to be based on a misunderstanding of how the leak rate calculation applies, as the commenter states that it would be impossible to know how much refrigerant was leaked from each individual leak. The Agency clarifies that the leak rate calculation is required when refrigerant is added to an appliance. The leak repair requirements of the final rule are triggered when an appliance reaches a leak rate above the applicable leak rate thresholds described in section IV.C.2.b. of this preamble. EPA is not requiring the mandatory repair of all leaks discovered by an appliance owner. The Agency is requiring leak repair for appliances above the applicable leak rate and requiring the appliance owner to conduct leak repairs so that the appliance is leaking below that threshold. While certain documentation is required for individual leaks, that does not mean that the leak rate calculation needs to be applied to each leak individually. The commenter also asked for clarity of the leak rate calculation in the event of multiple simultaneous leaks. EPA responds that simultaneous leaks on the same appliance identified at the same time (*e.g.*, during the same inspection or servicing event) would require just one leak rate calculation. The addition of refrigerant to an appliance triggers the leak rate calculation for the appliance. If the appliance is leaking above the applicable leak rate threshold the owner or operator must comply with the leak repair requirement and as part of that process may uncover several leaks within an appliance that may require repair in order to bring the appliance under the applicable leak rate threshold.

Comment: One commenter recommended that EPA consider allowing leak rate calculations from indirect ALD systems if acceptable accuracy can be demonstrated at least 85 percent of the time. The commenter claims their manufactured indirect ALD, with reliable data, has the ability to calculate leak rates (in pounds per day) with a margin of error of +/- 25 percent.

Response: EPA acknowledges the suggestion on how indirect ALD could be further used to manage leaks but disagrees that it is an acceptable or viable alternative to the leak rate calculations required by this final rule. Performing a leak rate calculation using one of the methods in the final rule will provide a facility owner with an accurate leak rate to determine if further leak repair action is necessary every time. An approach that need only be demonstrated to be accurate 85 percent of the time, as commenter requested, could result in the failure to identify and address leaks that exceed the leak rate threshold and that this rule intends to address. Additionally, while an indirect ALD system can calculate daily leak rates, the margin of error would cause the leak rate calculation to be inaccurate. The leak rate methodologies provide an accurate snapshot of an appliance's leak rate when refrigerant is added and provides an owner or operator with an immediate determination of whether an appliance needs to be repaired.

Comment: One commenter requested clarification on whether the addition of certain components to existing appliances where refrigerant is added would require a leak rate calculation, using the example of an installation of a new refrigerated case in an existing supermarket system. The commenter indicated the addition would necessitate a charge size adjustment and the addition of new refrigerant to meet the appliances' new BTU/h load. The commenter further stated that in this scenario the refrigerant added to an existing appliance was not to replace leaked refrigerant and that EPA should provide an exception to the leak rate calculation provision in these specific cases.

Response: EPA clarifies that the immediate addition of refrigerant following a retrofit, installation of a new appliance, or seasonal variance does not require a leak rate calculation. The Agency agrees that the addition of refrigerant immediately after additional components are added to an existing appliance does not reflect a leak within the appliances, and thus does not necessitate a leak rate calculation. However, EPA clarifies that a full charge calculation, as outlined in section IV.A.1. of this preamble, must be conducted to determine the change in charge size when additional appliances are added to an existing system. The determination of an appliance's full charge is necessary for subsequent leak rate calculations.

b. Requirement to repair leaks, timing and applicable leak rates.

EPA is finalizing several leak repair requirements related to determining when a leak needs to be repaired, the extent of the repair required, and the timing of such repairs as proposed. EPA is requiring the repair of leaks in refrigerant-containing appliances with a charge size of 15 pounds or more with a refrigerant that contains an HFC or a substitute for an HFC with a GWP above 53. Under this rulemaking, owners or operators are required to repair an appliance within 30 days (or 120 days if an industrial process shutdown is required) of refrigerant being added to an appliance, if the appliance is leaking above the applicable leak rate. These timing requirements are consistent with the requirements found at 40 CFR 82.157(d) to repair leaks for ODS-containing equipment. Repairing leaks in a timely manner helps serve the purposes identified in subsection (h)(1). For example, timely repair is critical to reducing the emissions of refrigerants from leaking appliances, and thus to minimizing releases of HFCs from equipment. In addition, by repairing leaks in a timely manner, additional HFC refrigerant will be subsequently available for reclamation, which supports maximizing reclaiming of HFCs.

In some unforeseen circumstances, repair of leaks may require additional time beyond that of the timeframe. EPA is finalizing specific extensions that may be available for owners or operators to repair leaks if certain conditions are met. Among these conditions, EPA is requiring that one or more must be met to qualify for additional time. Extensions for the leak repair requirements are available if the appliance is located in an area subject to radiological contamination or if shutting down the appliance will directly lead to radiological contamination. Additional time is permitted to the extent necessary to allow the completion of the repairs in a safe working environment. Extensions are also available to owners or operators if the requirements of any other federal, state, local, or tribal regulations make a repair within 30 days (or 120 days if an industrial process shutdown is required) impossible. Additional time is permitted to the extent needed to comply with the applicable regulations. EPA is also finalizing extensions for when needed components that must be replaced as a part of the leak repair are not available within the leak repair timeframe of 30 days (or 120 days if an industrial process shutdown is required). In this case, additional time is permitted of up to 30 days after receiving the needed component, with the total extension not to exceed 180 days (or 270 days if an industrial process shutdown is required) from the date that the appliance exceeded the applicable leak rate. In all cases of potential extensions to the leak repair timeframe, an owner or operator is still required to repair leaks that the technician has identified as significantly contributing to the exceedance of the applicable leak rate and that do not require additional time and to verify those repairs within the initial 30 days (or 120 days if an industrial process shutdown is required). Owners or operators availing themselves of this flexibility are also required to document all repair efforts and provide a reason for the inability to repair the leak within the initial 30-day (or 120-day if an industrial process shutdown is required) time period. All extension requests must be submitted electronically in a format specified by EPA and include pertinent information as described in the regulatory text at 40 CFR 84.106.

In the final rule, a leak is presumed to be repaired if there is no further addition of refrigerant to the equipment for 12 months after the date of repair as demonstrated by a successful follow-up verification test or if there are no leaks identified by either the required periodic leak inspection(s) or an ALD system, where applicable. Further information on the requirements for ALD systems are described in section IV.D.1. of this preamble. While EPA is requiring ALD systems for certain refrigerant-containing appliances, there may be some cases where an owner or operator chooses to use ALD systems for equipment where it is not required.

Whether use of the ALD system is due to requirements in section IV.D.1. of this preamble or used as a compliance option in lieu of leak inspections (see section IV.C.3.d. of this preamble) for a specific appliance, if the ALD system detects a leak in the 12-month period after the date of repair as demonstrated by a successful follow-up verification test, the leak repair would be presumed to have subsequently failed, unless the owner or operator can document that the ALD system leak detection was due to a new leak that is unrelated to the previously repaired leak. Such documentation includes, but is not limited to, the records required to be kept under 40 CFR 84.108(i). Additional information on leak inspections is described in section IV.C.3.d. of this preamble. If an appliance is mothballed, the timeframes for repair, inspections, and verification tests are temporarily suspended and will resume when additional refrigerant is added to the appliance (or component of an appliance if the leaking component was isolated).

Comment: EPA received several comments related to the leak repair timeline in the proposed rule. One comment, in support of the leak repair provision, appreciated the clear timeline for leak repair and ability to extend the timeline for repairing leaks to account for delays in component shipments and arrivals. Some commenters requested EPA lower the number of days to repair after initial detection. One commenter suggested the Agency align its leak repair timeline with CARB, requiring leaks to be repaired within 14 days after initial detection to provide additional emissions reductions and reduce refrigerant costs to appliance owners and operators. The commenter shared that between 2020 and 2022, 99 percent of leak repairs under CARB’s refrigerant management program were completed within the 14-day window. The commenter preferred EPA set the time extension to 45 days from the date of leak detection for situations where certified technicians or necessary components are not available and when an industrial process shutdown is required. The commenter did not support any extension more than

180 days. Another commenter did not support leak repair extensions for appliances with smaller refrigerant charge sizes.

Response: The Agency acknowledges the comments in support of the provision. The Agency is finalizing the requirements for the timely repair of leaks as proposed, recognizing that these timelines and the potential extensions are consistent with the longstanding requirements under 40 CFR part 82, subpart F. EPA is not finalizing a shorter leak repair timeline in the final rule, as one commenter suggested. The Agency recognizes that leaks often can be adequately repaired in under 30 days, including, as the commenter stated, in as little as 14 days. However, EPA finds it prudent to keep the existing leak repair timeline and extensions in part because EPA anticipates that applying a time frame that is consistent with the leak repair timeline under part 82, subpart F, will facilitate compliance with both regimes and reduce the potential for confusion. The Agency encourages owners or operators to strive to repair leaks as soon as practicable and in less than the required timeframes when possible, so as to, for example, reduce emissions, improve system efficiencies, and avoid spoilage of perishable goods. However, in other circumstances the full 30 days may be needed to adequately complete the repairs, so the final rule's leak repair timeline provides owners or operators with sufficient time and flexibility to repair leaks correctly. It also provides owners or operators an opportunity to extend the leak repair time up to 180 days (270 in the event of an industrial process shutdown) if sufficient reasoning is provided. Additionally, EPA notes that the final rule's leak repair extension provisions encourage the proper repair of an appliance where additional time is needed. In EPA's view, such repairs may include the replacement of major components, if necessary, rather than simply patching those components, an approach that may not be successful in the longer term. Furthermore, some owners or operators may prefer to replace a faulty component before they are required to retrofit or retire an entire appliance and believe this could, in many instances, be an equally effective means to address needed repairs. This extension should also reduce the potentially large burden upon owners or operators of requiring a large-scale retrofit or retirement when replacing the leaking component might satisfactorily repair the appliance. For these reasons, EPA disagrees with one commenter's recommendation that the Agency adopt a shorter leak repair timeline (*i.e.*, 14 days) or not allow timeline extensions beyond 180 days.

EPA is also not differentiating the leak repair timeline based on charge sizes as one commenter recommended. This final rule lowered the applicable charge size threshold for leak repair to 15 pounds, extending leak repair requirements to refrigerant-containing appliances not previously subject to the leak repair provisions under part 82, subpart F. In this action, the leak repair timeline for all appliances is the same regardless of charge sizes. Although appliances at lower charge sizes may be less complex and easier to repair in a timeframe lower than 30 days, the Agency reiterates the final rule's repair timeline is intended to provide sufficient time to correctly repair appliances below their applicable leak rate thresholds. EPA also notes that smaller refrigerant-containing appliances are not precluded from submitting extension requests as long as the owner/operator has provided sufficient reasoning. The only narrow differentiation in the timing of leak repair in the final rule is for IPR systems in the event of an industrial process shutdown due to the complexity of adequately repairing these refrigerant-containing appliances. Additionally, the Agency views this change as unnecessary because the addition of variable leak repair timelines based on charge size may introduce additional complexity and reduce compliance with the provision. As discussed previously, the leak repair timeline under this final rule is consistent with the leak repair timeline under part 82, subpart F, as a means of facilitating compliance with both regimes and reducing confusion for owners or operators.

Comment: A few commenters requested the compliance timelines for leak repair be extended. Two of the commenters emphasized that the complexity and size of supermarket and IPR systems, the current shortage of technicians, the long lead time for obtaining replacement equipment, and potential operational disruptions will make the leak repair timeline unfeasible. One commenter requested that the timeline extension should not be limited to a maximum of 180 or 270 days because the process to identify and repair a leak in IPR appliances is likely to exceed the applicable timeframes. Another commenter suggested that all but *de minimis* leaks be identified and repaired "promptly" without a specified deadline. The commenter stated that EPA could require an owner/operator to report the progress of leak repair without an arbitrary mandatory deadline. Alternatively, the commenter suggested EPA should not start the leak repair "clock" when a leak is detected but rather when the exact location of a leak is determined, further claiming this would allow technicians time to implement mitigation measures and reduces any incentive for owners and operators to delay repairs. Another commenter suggested EPA could consider an exception process to grant additional time and temporarily or permanently extend the leak repair timeline for situations with technician and component shortages, supply chain disruptions, and other reasonable circumstances.

Response: EPA disagrees with the commenter's recommendation that leak repairs should not have a set timeline for completion or that EPA should consider an exception process. Timely repair of leaks contributes to reducing emissions. As stated in responses to other similar comments, the Agency understands that repairs often happen faster than the designated timelines. Regarding IPR appliances, the Agency is aware, as the commenter stated, that IPR appliances are large and complex and may require additional time or operational shutdowns to determine the leak location. The regulation includes a longer timeline for repairs to IPR, which EPA considers appropriate in light of the differences between IPR and other appliances. Similarly, although supermarket systems and commercial refrigeration systems may be complex, owners or operators should typically be able to repair appliance leaks under the applicable threshold within the final rule's allotted timeframe. For example, the final rule allots up to 180 days for commercial refrigeration appliances (*e.g.*, supermarket systems) to complete repairs in the event necessary components or replacement equipment are not readily available (noting that the owner/operator would need to complete the repair within 30 days of receiving the missing component or replacement equipment).

EPA disagrees that owners or operators would be unable to determine the location of a leak and repair the leak within 30 days (120 days for an industrial process shutdown). As experience with the CAA section 608 programs shows, these have been reasonable timelines, including for IPR and commercial refrigeration appliances with charge sizes of 50 pounds or higher. The Agency also notes that extension requests function similarly as they did under the CAA, providing a process for an owner/operator to extend the timeline in the event of technician shortages, component supply issues, and industrial process shutdowns. If an extension is not available and the leak repair requirements cannot be met in the final rule's timeframe (*e.g.*, due to the severity of the leak or condition of the appliance), the owner or operator would need to create a retrofit or retirement plan as described in section IV.C.3.f. of this preamble. Allowing for an unlimited time to repair leaks would not provide any incentive for an owner or operator to repair the leak, which would release more refrigerant from the equipment and thus make less HFCs available for recovery from the appliance and reclamation.

EPA also disagrees with one commenter's assertion that the 30-day leak repair timeline is arbitrary. The authority granted to EPA under subsection (h) of the AIM Act directs the Agency to establish certain regulations for purposes including minimizing the release of regulated substances from equipment and maximizing the reclamation of regulated substances. The Agency concludes that the final rule's leak repair timeline is an important component of the leak repair requirements serving these statutory purposes while also providing owners and operators with the flexibility to repair leaks in a timely and efficient manner. The Agency reiterates that the same leak repair timeline has been in effect under the CAA section 608 regulations for decades. For similar reasons, the Agency disagrees with one commenter's suggestion to not start the leak repair "clock" until the exact location of the leak is detected. EPA disagrees that this method of leak repair timing would reduce incentive for owners or operators to delay the repair of leaks. The Agency views the commenter's suggestion as providing an indeterminate amount of time to repair leaks, which in turn incentivizes owners or operators to delay finding and repairing leaks, as the timeline for repair is subject to the discovery of a leak location, not based on the appliance leaking above the applicable leak rate threshold. The final rule provides ample time for owners or operators to determine the source of an appliance's leak and provides additional flexibility to extend the leak repair timeline if certain conditions are met. Thus, the Agency finds the commenter's suggested approach flawed with regard to repairing leaks in a timely manner. The Agency also disagrees with the commenter's request that EPA require all but *de minimis* leaks to be repaired. In the context of the prohibition on venting or otherwise releasing into the environment any refrigerant under CAA section 608 (40 CFR 82.154), the term "*de minimis*" refers to releases associated with good faith attempts to recycle and recover refrigerants, noting that such releases are not subject to the prohibition. In other words, were EPA to require all but *de minimis* leaks to be repaired, and to interpret the term consistently with how it has been interpreted under CAA section 608, the Agency would be finalizing repair of nearly all leaks, not repairs to below a threshold. That would be a significant change that the Agency did not propose and is not finalizing in this rulemaking.

Comment: One commenter suggested that EPA should also consider a condition that the refrigerant must be removed to trigger the proposed leak validation exclusion for mothballed equipment.

Response: EPA is unclear as to what the commenter refers to as a "leak validation exclusion"; however, we clarify that mothballed appliances must have their refrigerant evacuated before the leak repair timeline is suspended. The definition of "mothball" is available at 40 CFR 84.104, which is being finalized in this action, and reads:

> *Mothball*, as it relates to a refrigerant-containing appliance, means to evacuate refrigerant from an appliance, or the affected isolated section or component of an appliance, to at least atmospheric pressure, and to temporarily shut down that appliance.

EPA is finalizing the applicable leak rate thresholds for refrigerant-containing appliances with a charge size of 15 pounds or more with a refrigerant that contains an HFC or a substitute for an HFC with a GWP above 53 as follows: 20 percent leak rate for commercial refrigeration equipment; 30 percent leak rate for IPR equipment; and 10 percent leak rate for comfort cooling appliances, refrigerated transport appliances, or other refrigerant-containing appliances not covered as commercial or industrial refrigeration appliances. The leak rate thresholds are used to determine whether repair is needed for an appliance that is leaking, as the leak repair requirements are triggered if the appliance exceeds the leak rate threshold. *See* 40 CFR 84.106(c)(2). EPA is applying applicable leak rates that mirror those currently in effect for ODS-containing appliances under the 2016 CAA Section 608 Rule. *See* 40 CFR 82.157(c) (d). These rates were in effect for appliances containing 50 pounds or more of HFCs for a period of time.

After reviewing the information and analysis that supported application of these leak rates to those HFC appliances and considering the provisions of subsection (h) and the comments offered on the proposal to extend these thresholds to the equipment subject to the leak repair requirements under this rule, EPA has determined it is appropriate to finalize them, as proposed, in this action.

As discussed in section IV.C.2. of this preamble, EPA is finalizing, as proposed, the application of leak repair requirements to appliances using an HFC and/or a substitute for HFCs with a GWP greater than 53, as a refrigerant (neat or in blends) based on a charge size threshold of 15 pounds or greater, with certain exceptions. EPA is requiring the use of the same leak rate threshold across categories of equipment for all covered appliances. In other words, a 20 percent leak trigger rate applies for commercial refrigeration equipment with a full charge size of 15 pounds or more, and a 10 percent trigger leak rate applies for comfort cooling appliances with a full charge size of 15 pounds or more. For refrigerant-containing appliances in certain subsectors and applications that have not been previously covered under 40 CFR 82.157, EPA is finalizing determinations for the applicable leak rates listed in 40 CFR 84.106(c)(2)(iii). For example, for refrigerated transport – rail, EPA is finalizing that this application is considered under the comfort cooling and other appliances category and has an applicable leak rate of 10 percent.

As noted in the proposal, EPA views these applicable leak rates per the type of appliance as appropriate for the leak repair provisions in this action under subsection (h) of the AIM Act. This rulemaking draws on EPA's experience implementing similar requirements under CAA section 608, where these thresholds have provided a practical and effective method for determining when leaks must be repaired. In the proposal, the Agency considered whether a lower percent leak rate for some or all of the categories of appliances would be more appropriate for appliances that contain HFCs and/or substitutes for HFCs. EPA reviewed the docket for the 2016 CAA Section 608 Rule, which lowered the applicable leak rates for each of the appliance categories.[67,68] EPA also evaluated leak rate data of appliances in each of the applicable categories to determine the appropriate applicable leak rates and reviewed information from stakeholders shared during public meetings held in the development of this rulemaking.[69] EPA did not propose and is not finalizing changes to the applicable leak rates for categories of appliances containing HFCs and covered substitutes. However, the Agency notes that we could revisit the applicable leak rates as appropriate to support the overall purposes of subsection (h) in the future.

Comment: EPA received mixed support for the applicable leak rates for commercial refrigeration, IPR, and comfort cooling. Some commenters stated that EPA could go lower for some of the appliance sectors, and others argued for EPA to increase the leak rate thresholds for certain subsectors. One commenter, in support of the provision, stated that leak rate thresholds aligned with the CAA section 608 regulations are appropriate and should not be further adjusted. Another commenter echoed that the leak rate thresholds did not need to be changed because the final rule would already subject a large group of appliances to mandatory time-limited repairs, reporting, and in some cases, retrofit or retirement. The same commenter stated that lowering the leak rate threshold would make appliances impossible to manage due to the number of appliances affected by the leak repair provisions in the final rule.

[67] Docket No. EPA-HQ-OAR-2015-0453

[68] For further information, please see the discussion in the 2016 CAA Section 608 Rule at 81 FR 82272, 82317 and the technical support document, Analysis of the Economic Impact and Benefits of Final Revisions to the National Recycling and Emission Reduction Program, available in the docket for the 2016 CAA Section 608 Rule (EPA-HQ-OAR-2015-0453)

[69] EPA held stakeholder meetings for public input on November 9, 2022, and March 16, 2023, and also solicited feedback through a webinar for EPA's GreenChill Partnership program on April 12, 2023.

Two commenters did not support the proposed leak rates, citing difficulty to manage, number of systems it would affect from the outset, and impracticality and burden of the requirements. One commenter stated that small chillers used in the semiconductor industry are not applicable to the provision because leaking chillers are normally removed from service. The commenter requested clarity on whether equipment removed from service is exempt from the leak repair requirement. One of the commenters stated that typical food retail refrigeration appliances have an estimated 25 percent annual leak and the rule would force the average supermarket system into immediate repair, verification, and potential retrofit or retirement. The commenter also suggested EPA eliminate the leak rate thresholds altogether and allow operators to perform a calendar year leak rate calculation each time the operator adds refrigerant, as owners or operators are incentivized to repair leaks to avoid high refrigerant costs and store operations.

Several commenters did not support EPA's proposed leak rate threshold of 20 percent for commercial refrigeration appliances and suggested lower targets to ensure climate and economic benefits. Commenters recommended EPA lower the applicable leak rate to 15 percent. One commenter incorrectly stated that the GreenChill voluntary program requires a maximum 15 percent leak rate for stores and 5 percent for the platinum standard, which over half of certified stores in this program have achieved.

EPA received similar comments regarding the 30 percent leak rate threshold for IPR. Several commenters recommended EPA lower the applicable leak rate for IPR to 20 percent. The commenters also stated that the 20 percent threshold would align with CARB's refrigerant management program and push more facilities to require mandatory repairs. One commenter stated that an IPR system can leak a quarter of its full charge without triggering any leak repair requirements. The commenter asserted that a facility leaking 25 percent of its refrigerant annually will leak out five times as much refrigerant over the course of its life as will be available to recover when it is eventually retired. The commenter also stated that trigger leak rates create a perverse incentive for underreporting and repairing leaks and suggested the Agency revisit these thresholds in the future. Another commenter suggested EPA instate a 10 percent leak rate for IPR chillers specifically because they are compact, sealed appliances with a similar design to comfort cooling appliances that have a 10 percent leak rate threshold. Another commenter suggested the IPR and comfort cooling leak rates should align with Washington State's requirements of 24 percent and 8 percent, respectively. The commenter also urged EPA to consider setting a time frame to revisit reducing these leak thresholds to provide greater climate benefits and guarantee that leak detection systems meet minimum standards.

Response: The Agency is finalizing the leak rate thresholds as proposed. When developing the proposed rule, the Agency considered a number of options for the appropriate leak rate thresholds for commercial refrigeration, IPR, and comfort cooling and decided on proposed requirements that were consistent with the trigger rates that were finalized in the 2016 CAA Section 608 Rule. Under the 2016 CAA Section 608 Rule, EPA determined that lowering the leak rate thresholds was reasonable when considering the compliance costs, savings, environmental benefits and fewer emissions of both ODS and, at the time, non-exempt substitute refrigerants (*i.e.,* HFCs). The Agency found it prudent to align the leak rate thresholds in this final rule with CAA section 608 based on similar factors. Further, the alignment of this provision with leak rate thresholds under CAA section 608 should assist in facilitating compliance with the provision, as owner/operators should be familiar with the similar requirements under CAA section 608. EPA also notes that this rulemaking extends the leak repair requirements to a larger group of appliances that were previously not subject to the leak repair requirements under CAA section 608. The Agency wants to ensure that all appliances subject to the leak repair requirements are able to meet the standards in the provision, and lowering the leak rates at this time may further limit compliance with the provisions of this final rule. Commenters' views include those expressing support for consistency and those suggesting more or less stringent trigger rates. None of these commenters provided sufficient information to conclude that a more or less stringent trigger rate is appropriate. Therefore, EPA is finalizing, as proposed, trigger rates that generally align with 40 CFR part 82, subpart F, in agreement with commenters indicating a preference for consistency. EPA notes that we may revisit the leak rate thresholds in the future through a separate notice-and-comment rulemaking if the Agency finds that the alternate thresholds suggested by commenters are warranted. Furthermore, the Agency disagrees with one commenter's argument that leak rate thresholds creates perverse incentives to underreport leaks and avoid repair of appliances. Leak rate thresholds have been utilized as a method of compliance for leak repair for nearly 30 years under the rationale that fixing all leaks in an appliance may hamper compliance and force appliances into early retrofit or retirement before the end of their useful life. EPA acknowledges that, for example, small pin hole leaks in a complex IPR system may be hard to find and repair and ultimately have a low leak rate compared to larger leak events that push a refrigerant-containing appliance above the applicable leak rate threshold. As stated previously in the preamble, when the applicable leak rate is exceeded, repairing those leaks is warranted to minimize the release of refrigerants from equipment.

EPA disagrees with commenters' assertions that the leak rate thresholds would be unduly burdensome. While there are more affected appliances under this final rule given the lower charge size threshold compared to ODS appliances, the Agency notes that on the whole, commenters supported that 15-pound threshold. Moreover, there have been changes to the appliance design since the Agency first established leak repair requirements for ODS refrigerant-containing appliances. The Agency does not view applying the leak repair provisions in this final rule, specifically the applicable leak rate threshold, to appliances with a charge size between 15 and 50 pounds as unduly burdensome. Many of the appliances with a charge size under 50 pounds have an applicable leak rate of 10 percent (*e.g.*, appliances that are not IPR or commercial refrigeration); however, refrigerant-containing appliances at this charge size are at a relatively low risk of leaking compared to larger appliances. Additionally, appliances closer to a charge size of 15 pounds are also more likely to be hermetically sealed and thus have a low leak potential. Furthermore, as detailed in IV.C.2 of this preamble, EPA has provided a narrow exemption from the leak repair provision for residential and light commercial air conditioning and heat pumps, which will further limit the number of refrigerant-containing appliance subject to the leak repair requirements.

Further, given that HFCs are being phased down as compared to ODS, which are being phased out, HFCs and HFC substitute refrigerants can be used indefinitely. Given that there is no date by which HFCs can longer be charged into appliances, it is paramount that EPA take steps to prevent leaks, reduce emissions, and maximize reclamation. Additionally, because the HFC phasedown will greatly limit the supply of virgin HFCs available to service appliances, the timely repair of leaks is required to limit the emissions of HFCs. The leak rate thresholds, in the final rule, facilitate the timely repair of leaking appliances, which will mitigate the amount of refrigerant lost and needed to service an appliance. Leak rate thresholds ensure owners and operators will take appropriate action to repair leaks so that their appliances are below the applicable leak rate threshold.

In regard to chillers used in the semiconductor industry, the commenter stated that small semiconductor chillers are typically removed from service if they begin leaking. EPA understands that these chillers are distinct, hermetically sealed devices that are removed when in need of servicing, and that such servicing is performed at a separate location, including at locations outside of the United States. If the chiller contains less than 15 pounds of refrigerant, as would be the case with many in this industry, the leak repair requirements do not apply. For chillers with 15 pounds of refrigerant or more, the Agency clarifies that appliances removed from service, that have their full charge evacuated and recovered, are not subject to the full suite of the leak repair requirements. An owner/operator may do this to conduct further repairs, to mothball the appliance for future repairs, or due to a retrofit or retirement plan (see section IV.C.3.f of this preamble). In the specific case of these semiconductor chillers, once the determination has been made that the appliance is leaking above the threshold rate and needs to be taken out of service, the owner/operator would need to evacuate and recover all refrigerant from the appliance in a way similar to how an owner/operator would mothball an appliance. Once repairs are made and the appliance is recharged for service, it is required to meet all of the requirements in the final rule's leak repair provision.

EPA also disagrees with one commenter's suggestion to forego leak rate thresholds in favor of allowing calendar year leak rate calculations each time the owner or operator adds refrigerant because owners and operators should already be using some methodology for calculating their leak rate after annual or quarterly leak inspections. The Agency clarifies that leak inspections and the calculation of a leak rate does not equate to leak repair. Under the provisions finalized in this action, if an appliance is leaking above the applicable leak rate threshold, the owner or operator must repair any leaks to ensure the appliance's leak rate is brought below said threshold. Without a leak rate threshold there would not be a clear metric for determining when the leak repair requirements were triggered or when the appliance had been sufficiently repaired. The Agency also disagrees that appliance owners would repair leaks in a timely manner based on the incentive to save on refrigerant costs or to avoid operational disruptions alone. While EPA agrees that the leak repair provisions in this final rule are anticipated to have the effect of avoiding additional refrigerant costs and operational disruptions in many situations, financial motivations to conduct leak repair do not always align with the rule's purpose of minimizing the release of HFCs and their covered substitutes. For example, an owner/operator, in some cases, may find it more financially optimal to continually add refrigerant to an appliance instead of repairing it, or an owner/operator may not have adequate information about the costs associated with failure to repair leaks in making decisions about whether to voluntarily repair leaks. In EPA's view, the leak rate thresholds are an important part of the regulatory design of the leak repair requirements and help ensure that they serve the statutory purposes identified for regulations under subsection (h) to minimize the release of regulated substances from equipment and maximize reclamation.

The commenter also stated that the average annual leak rates for supermarkets is 25 percent and that the rule would require immediate repair of supermarket systems. The Agency responds that the purpose of the final rule is to minimize the release of regulated substances from appliances. If a supermarket system is leaking at a rate higher than 20 percent, the owner/operator would be required to repair leaks to the extent and within the timeframe specified in the final rule. Furthermore, the Agency disagrees with the commenter's assertion that the final rule would force supermarket owner/operators to repair and potentially retrofit or retire systems immediately, once the leak repair provisions go into effect, because the average supermarket has an annual leak rate of 25 percent. EPA reiterates that the leak repair provisions of this final rule are relatively consistent with the requirements for ODS refrigerants that have been and continue to be in use in supermarkets throughout the United States. EPA has also extended the compliance date for the leak repair provision by one year to further accommodate owner/operators' compliance with the provision. Moreover, the Agency notes that the 25 percent leak rate average that FMI cites for supermarkets is nearly double the less than 15 percent average leak rate GreenChill partners voluntarily report to EPA on an annual basis. Many GreenChill partners have been able to consistently achieve lower leak rates by adopting newer system technologies, using newer refrigerants, applying best practices, and maintaining leak-tight systems to decrease refrigerant emissions. The GreenChill voluntary partnership has also hosted webinars discussing these topics, which are available to the public. The purpose of this rule is to minimize the release of regulated substances from appliances. If any commercial refrigeration system is leaking above the applicable leak rate of 20 percent an owner or operator is required to take the necessary steps to repair their appliance to the extent required within the timeframe specified in this final rule.

In response to one commenter's characterization of leak rates reported under the GreenChill voluntary partnership, the Agency clarifies that GreenChill does not have any requirements for specific leak rates in order to be a member. The leak rate thresholds cited by the commenter are award thresholds used by the Agency to recognize lower leak rates reported to EPA. The partnership represents over a third of U.S. supermarkets; however, the Agency does not know if supermarkets not in the GreenChill voluntary partnership are doing better or worse than the voluntary members. As previously stated, the Agency may reconsider the leak rate thresholds in a future notice-and-comment rulemaking but cannot justify changes to those thresholds solely on the basis of voluntary reporting under the GreenChill voluntary partnership.

c. Verification testing

EPA is finalizing its requirements for initial and follow-up verification tests as proposed. The Agency is requiring initial and follow-up verification for refrigerant-containing appliances with a charge size of 15 pounds or more of a refrigerant that contains an HFC or a substitute for an HFC with a GWP above 53 as a part of the leak repair provisions under subsection (h). These requirements are analogous to similar provisions for affected ODS-containing appliances under CAA section 608 under 40 CFR 82.157(e). The final rule requires owners or operators to conduct initial and follow-up verification tests within specified timeframes for each leak that is repaired. The initial verification test is required to be performed within 30 days (or 120 days if an industrial process shutdown is required) of an appliance exceeding the applicable leak rate and must demonstrate that leaks are repaired, where a repair attempt was made. The initial verification test verifies that the leak has been repaired prior to adding refrigerant back into the appliance, and the follow-up verification test confirms that the repair held after refrigerant has been added and the appliance has been brought back to normal operating characteristics. The follow-up verification test is required to be conducted within 10 days of a successful initial verification test or 10 days after the appliance has returned to normal operating conditions (if the appliance or isolated component of the appliance was evacuated to perform repairs). The follow-up verification test is necessary to confirm that the leak repair has held after the refrigerant-containing appliance has been recharged, pressurized, and returned to normal operating conditions. If the initial or follow-up verification tests indicates that a leak repair was not successful, the owner or operator may conduct as many additional repairs and initial or follow-up verification tests as needed to achieve a successful leak repair within the applicable time period.

EPA notes that in some cases, a follow-up verification test may be impossible; for example, when it would be unsafe to be present when the system is at normal operating characteristics and conditions. Where it is unsafe to be present or otherwise impossible to conduct a follow-up verification test when the system is at normal operating characteristics and conditions, the Agency is requiring that where practicable, the follow-up verification test be conducted prior to the system returning to normal operating characteristics and conditions. In such situations, the owner or operator has the burden of showing that it was unsafe to be present when the system is at normal operating characteristics and conditions.

As discussed in the proposal, verification testing involves important practices, processes, and activities regarding the repair and servicing of equipment. The tests are performed shortly after an appliance has been repaired to confirm that the leak has been successfully repaired. Without the verification tests, it may take additional time for the owner or operator to realize that the repair has been unsuccessful and during that time refrigerant could continue to leak from the appliance. The provision is designed to help ensure that leaks are repaired successfully and that the repair holds, so that repair has the intended effect of limiting refrigerant emissions from the appliance. EPA is finalizing requirements that the verification tests must be performed for all leak repairs to ensure that the leak repair is done correctly the first time, holds, and has its intended effect, which will help minimize releases of HFCs from the appliance, and also help maximize HFCs available for eventual reclamation by limiting such releases.

Comment: A commenter stated that a properly commissioned system should not require an additional verification step in later weeks or follow-up leak requirements. They argue that properly commissioned maintenance work, as required by UL 60335-2-40 and UL 60335-2-89, or another appropriate standard should be sufficient. The commenter recommended EPA restrict this requirement to systems with very large charge sizes, perhaps above 500 pounds, to be consistent with other thresholds set in the rule. The commenter also suggested EPA should require reporting if a leak is repaired in a system that has to be recharged again within six months.

Response: EPA is finalizing the verification test provision as proposed. The Agency disagrees that properly commissioned maintenance work does not need to go through the leak repair verification process. The standards required by UL 60335-2-40 and UL 60335-2-89 are industry standards, developed by consensus and concerned with appliance design and manufacture. The standards do not speak to the operations of an appliance over multiple years. Instead, UL standardizes leak prevention requirements in the appliance's design, standardizes leak detection through sensors or other mechanisms, and provides standards to mitigate the release of refrigerants via releasable charge considerations.[70] Moreover, the leak repair requirements and thus the need for verification tests begin when an appliance exceeds its applicable leak rate. If an appliance is well designed and follows practices consistent with the requirements of the standard, perhaps there will not be an occurrence of leaks that result in an exceedance of the applicable leak rate and thus the owner/operator would not need to proceed with the final rule's leak repair process.

The Agency also disagrees that the verification requirement be restricted to appliances with very large charge sizes because the purpose of the provision is to ensure that leaks are

[70] ASHRAE Standard 15–2022 defines releasable charge as a portion of the system refrigerant charge that can be released into a space as a result of a single point failure.

properly repaired and that those repairs hold, such that the repair has its intended effect and emissions are minimized. We also disagree with the suggestion that EPA require reporting if an appliance is recharged within six months of a leak repair, as this is not a reasonable substitute for verification tests or leak inspections of repaired appliances. EPA clarifies that a leak is considered repaired if refrigerant is not added within 12 months of the previous leak repair or if there are no leaks identified by either the required periodic leak inspection(s) or an ALD system, where applicable. Verification tests ensure repairs hold and leak inspections verify that the repaired leak has not failed over a 12-month period; both are warranted portions of the leak repair process and support meeting the purposes identified in subsection (h)(1), including minimizing the release of regulated substances from equipment.

d. Leak inspections

The Agency is finalizing leak inspection requirements as proposed for refrigerant-containing appliances with a charge size of 15 pounds or more of a refrigerant that contains an HFC or substitute for an HFC with a GWP greater than 53 that are found to be leaking above the applicable leak rate threshold. As discussed in the proposal, the leak inspection requirements involve processes, practices, and activities regarding the repair of refrigerant-containing appliances that are designed to ensure the long-term effectiveness of a successful leak repair. Thus, the requirements will help minimize any releases of HFCs from equipment over time and also help maximize HFCs available for eventual reclamation by limiting such releases.

Leak inspection frequency is dependent on the type of appliance and the size of the appliance (by refrigerant charge size). For commercial refrigeration and IPR appliances that have a charge size of 500 pounds or more of a refrigerant that contains an HFC or a substitute for an HFC with a GWP greater than 53, EPA is requiring leak inspections to be performed every three months after the date of repair as demonstrated by a successful follow-up verification test until the owner or operator can demonstrate that the appliance has not exceeded the applicable leak rate for four consecutive quarters. For commercial refrigeration and IPR appliances that have a charge size between 15 and 500 pounds of a refrigerant that contains an HFC or a substitute for an HFC with a GWP greater than 53, EPA is requiring that leak inspections be performed once per year after the date of repair demonstrated by a successful follow-up verification test until the owner or operator can demonstrate that the refrigerant-containing appliance has not exceeded the applicable leak rate for one year (*i.e.*, 12 months). For comfort cooling and other appliances that have a charge size of 15 pounds or above of a refrigerant that contains an HFC or a substitute for an HFC with a GWP above 53, EPA is requiring that leak inspections be performed once per year after the date of repair demonstrated by a successful follow-up verification test until the owner or operator can demonstrate that the equipment has not exceeded the applicable leak rate for one year (*i.e.*, 12 months). In each case, to demonstrate an appliance has not exceeded the applicable leak rate, the leak rate is calculated during a leak inspection as described in section IV.C.3.a of this preamble. EPA is establishing that it is appropriate to require more frequent leak inspections for larger commercial refrigeration and IPR appliances (*i.e.*, charge sizes at or above 500 pounds), as the larger charge size means that potential emissions from the appliance are greater if a leak is not properly repaired.

EPA is also finalizing the use of ALD systems as a compliance option in lieu of quarterly or annual leak inspections. Owners or operators voluntarily using an ALD system to monitor leaks in a refrigerant-containing appliance that are not subject to the ALD requirements in the final rule (see section IV.D.1. of this preamble) are not required to conduct periodic leak inspections unless an applicable leak rate threshold has been exceeded. Once the applicable threshold has been exceeded the owner or operator is required to perform leak inspections on any portions of the appliance where the ALD system is not monitoring for leaks. Owners or operators choosing to install an ALD system, in lieu of the required leak inspections, must meet the requirements for ALD systems (including annual ALD system audit and calibration requirements). The Agency is also finalizing separate requirements for the use of ALD systems for commercial refrigeration and IPR appliances that have a charge size of 1,500 pounds or more of refrigerant that contains an HFC or a substitute for an HFC with a GWP above 53. That is, the leak inspections that are being codified at 40 CFR 84.106(g) and the requirements related to ALD systems that are being codified at 40 CFR 84.108 are separate provisions that apply in different circumstances. For further information and requirements related to ALD systems in this action, refer to section IV.D.1. of this preamble.

Comment: EPA received mostly supportive comments on the proposed rule's leak inspection provisions. One commenter supported the option to use ALD in lieu of quarterly or annual leak inspections Another commenter supported the provision to require periodic manual leak inspections for portions of the appliance that are not being monitored by an ALD system. The commenter suggested that EPA require quarterly inspections for portions of an appliance with a charge size of 1,500 pounds or more that are not covered by an ALD system regardless of whether the appliance is leaking above its applicable leak rate. Another commenter in support of the varying leak inspection requirements in the final rule encouraged EPA to adopt routine leak inspections regardless of whether the refrigerant-containing appliances are found to be leaking or not. The commenter stated that routine leak inspections are a good way to catch leaks early and prevent high-volume leakage. One commenter requested clarification on whether EPA intended for leak inspections to be performed "once per year" or "within 365 days of the repair." The commenter suggested the "within 365 days of the repair" interpretation would align with 40 CFR part 82, subpart F.

Response: EPA is finalizing the leak inspection requirements as proposed. We acknowledge the comments in support of the provision. EPA acknowledges one commenter's support for the use of ALD as a compliance option. This decision was based on considerations of previous utilization of ALD systems under CAA section 608 where the Agency provided additional flexibility to facility owners to opt into ALD. The Agency agrees that routine leak inspections are helpful in preventing high-volume leakage from appliances and generally recommends periodic leak inspections as a best practice, even for well-maintained appliances. EPA did not propose and is not finalizing the repair of all leaks or more frequent leak inspections; however, the Agency encourages owners or operators to adopt strategies to ensure their refrigerated-containing appliances are operating with minimal leaks. EPA clarifies that leak inspections are not tied to the discovery of a leak, but rather to the determination that an appliance is leaking above the applicable threshold and occur on a set timeline based on charge size (except for appliances where all portions of the appliance are monitored by ALD). EPA also clarifies that quarterly or annual leak inspections are required for portions of an appliance that are not being monitored by an ALD system when an appliance has exceeded its leak rate threshold. The Agency reiterates that the final rule is requiring the repair of leaks so that the appliance is under the applicable leak rate threshold, not the repair of all leaks. The addition of periodic inspections not related to the final rule's leak repair timeline would add additional burden to owner/operators and dampen the flexibilities in the leak repair provision. The Agency may reevaluate the frequency of leak inspections in a future notice-and-comment rulemaking but is not finalizing additional periodic leak inspections in this rulemaking.

The Agency disagrees with one commenter's suggestion to require periodic inspections of portions of an appliance not covered by an ALD system. EPA views the continuous monitoring of an appliance as serving the function of monitoring for leaks. Thus, a requirement for performing periodic leak inspections on those portions of the appliance is unneeded. The final rule does require leak inspections for portions of the appliance not monitored by ALD when the appliance is leaking above the applicable leak rate; however, this requirement is needed to ensure the repairs of leaks have not failed. Leak inspections serve as a method of determining whether repairs of refrigerant-containing appliances are adequate and if further action is needed.

The Agency clarifies that quarterly and annual leak inspections are to be conducted within 365 days from the date of repair, demonstrated by a successful follow-up verification test. For example, an owner or operator of a 500-pound IPR appliance that was found to be leaking above the applicable threshold would need to repair the leaks in the appliance (and conduct verification tests) so that the appliance is below the applicable threshold. The owner or operator, starting from the completion of repair, as demonstrated by a of a successful follow-up verification test, must then conduct quarterly leak inspections for a year and demonstrate that any leaks from the appliance are under the applicable threshold. Leak inspections would then cease until the next leak event above the applicable threshold occurs. The Agency also clarifies that the use of the term "calendar year" in the proposal's preamble was intended to mean "365 days" in the context of the timing of leak inspections.

Comment: One commenter objected to EPA implementing more frequent inspections than currently existing requirements under 40 CFR part 82, subpart F. Specifically, the commenter stated EPA should not require more frequent inspections than annually for systems between 15 and 500 pounds, and asserted that owners and operators would experience significant burden from more frequent inspections given the increase in appliances covered by the 15-pound threshold, the process for sniffing, and the additional work required if a leak is found. While the comment was less clear on this point, it also stated the view that it is not necessary to increase the frequency of leak inspections to be more than annual for equipment with a charge of 500 pounds or more.

Response: The Agency clarifies that the final rule's leak inspection requirements mirror the frequency of similar requirements under 40 CFR part 82.157(g). The Agency disagrees with the commenter's recommendation to only require annual leak inspections for all charge sizes. EPA is requiring quarterly inspections of appliances with charge sizes above 500 pounds given the risk of additional leaking (*e.g.*, that the leak could recur) once an appliance has exceeded the leak rate threshold and given that such large systems could release more refrigerant than smaller systems if additional leaking occurs. With these considerations, it is critical to ensure larger appliances are more frequently monitored for leaks. Quarterly leak inspections for large refrigerant-containing appliances ensure that the leak repair requirements operate as intended to minimize releases of HFCs from equipment, consistent with the purposes identified in subsection (h).

e. Chronically leaking appliances

As part of the leak repair provisions under subsection (h), EPA is finalizing specific requirements for refrigerant-containing appliances with a charge size of 15 pounds or more of a refrigerant that contains an HFC or a substitute for an HFC with a GWP above 53 that meet the criteria for a chronically leaking appliance. The requirements are designed to gather information and support efforts to address such chronic leaks, which have the effect of further minimizing emissions from equipment. A refrigerant-containing appliance is considered a chronically leaking appliance if it leaks 125 percent or more of its full charge within a calendar year. The requirements for chronically leaking appliances are similar, but not identical to, analogous requirements under 40 CFR 82.157(j). In the final rule, EPA is requiring reporting for covered refrigerant-containing appliances that meet the criteria to be considered chronically leaking. Submitted reports must describe the efforts taken to identify leaks and repair the appliance.

To better serve the purposes of minimizing releases of regulated substances and allow EPA to verify the information being reported more easily, EPA is standardizing the reporting format for chronically leaking appliances. EPA is requiring that the reports must be submitted no later than March 1 of the following calendar year of the ≥125 percent leak. EPA is requiring that these reports cover basic identification information (*i.e.*, owner name, facility name, facility address where appliance is located, and appliance ID or description), appliance type (comfort cooling, IPR, or commercial refrigeration), refrigerant type, full charge of appliance (pounds), annual percent refrigerant loss, dates of refrigerant addition, amounts of refrigerant added, date of last successful follow-up verification test, explanation of cause of refrigerant losses, repair actions taken, a signature from an authorized company official, and whether a retrofit or retirement plan has been developed for the appliance, and, if so, the anticipated date of retrofit or retirement. EPA proposed and is finalizing that these reports be submitted electronically in a format specified by EPA. The information in these reports would either be contained in the records EPA is establishing that owner or operators are required to maintain, or is the type of information that is on hand during the ordinary course of business. Because of the amount of refrigerant emitted, chronically leaking appliances warrant special attention. These reporting requirements for chronically leaking equipment are designed to help ensure that owners or operators are complying with the leak repair provisions and that they have taken appropriate steps to identify the leaks and correct the root cause of those leaks. These reports will allow EPA to evaluate compliance with the regulatory requirements and to identify entities that may benefit from compliance assistance and other outreach efforts. These reports will also allow EPA to assess common root causes for appliances that chronically leak, which would facilitate consideration of approaches to mitigate these leaks and minimize the releases of HFCs from such equipment. EPA discusses whether this information is entitled to confidential treatment in section V.A.1 of this preamble.

Comment: Some commenters suggested that EPA should require reporting when system leak rates exceed 110 percent per year rather than the proposed 125 percent value. One commenter indicated that this lower threshold would support close monitoring of systems that experience a loss of full charge so that unrepaired faults are repaired. One commenter suggested that EPA should set a quicker timeline for required leak repairs for chronically leaking appliances.

Response: The Agency is finalizing the chronically leaking appliances provision as proposed. EPA acknowledges the comments suggesting that it should lower the chronic leak rate but finds the 125 percent threshold more appropriate, as the Agency intends to focus on gathering information from chronically leaking appliances and to avoid capture of refrigerant-containing appliances affected by unavoidable losses that do not reflect a chronic issue. The 125 percent threshold allows the Agency to focus on chronic leakers, as systems would have to lose their full charge and then a significant quantity more to trigger the requirements. The Agency also notes that the 125 percent threshold aligns with the chronic leak rate established in the CAA section 608 regulations which may allow the Agency to compare or combine information obtained under this program with that obtained under CAA section 608 and develop a better understanding of the issues that lead to chronic leaking across a broader group of appliances. In response to the commenter's view that a chronic leak rate of 110 percent would support closer monitoring of appliances, especially appliances with large charge sizes, the Agency notes that a chronic leak rate of 110 percent may still capture appliances affected by unavoidable losses and thus dilute focus on the target group of appliances. One commenter requested that chronically leaking appliances be required to repair leaks on a quicker timeline. EPA responds that the timeline for repair of a chronically leaking appliance is the same as for any other appliance that triggers the leak repair requirements. The Agency further notes that some chronically leaking appliances would be subject to the retrofit or retirement provisions in the final rule, for example, if they continue to leak above the applicable leak rate after having conducted the required repairs and verification tests.

Comment: Another commenter suggested an alternative to EPA's proposal to require reporting when system leak rates exceed 125 percent in one year. The commenter suggested the annual leak rate percentage to require reporting should be 100 percent plus the allowed annual leak rate percentage for an equipment category plus five percent. Alternatively, the commenter suggested that EPA could choose a lower percentage and allow an exception for a single catastrophic leak.

Response: EPA disagrees with the commenter's suggested approach. The commenter's suggestion would allow certain appliances (*i.e.*, IPR) to leak 135 percent in one year before becoming subject to the chronic leaker provisions. Thus, for some appliances, the commenter's suggested approach would prevent EPA from obtaining information about certain appliances that may chronically leak but not at such a high rate, and thus might limit the Agency's understanding of the issues that may lead to chronic leaking at the 125 percent threshold. This approach would also differ from the approach under the CAA section 608 regulations, which may limit the Agency's ability to compare or combine the information obtained under this program with that obtained under CAA section 608. For the same reason, EPA is not adopting a lower percentage together with an exception for a single catastrophic leak event because EPA is not persuaded that this approach would allow us to obtain information focused on the appliances of most interest under this requirement.

Comment: One commenter stated that if EPA lowers the leak repair threshold to appliances with a charge size of 15 pounds, there will be a large number of reportable, chronically leaking appliances with full charge sizes between 15 and 49 pounds. The commenter stated that appliances with small charge sizes tend to lose their entire charge size before anyone realizes there is a leak, and therefore any appliance with more than one leak in a calendar year will be reportable to EPA. The commenter further claimed that the amount of refrigerant added to these small appliances does not necessarily reflect the amount of refrigerant leaked out of them, and that technicians tend to put whole cylinders worth of refrigerant into appliances whether the appliance requires it or not, because technicians do not like carrying partially empty cylinders on their trucks. The commenter asserted that this will lead to a larger number of chronically leaking appliances, not because these appliances are in fact leaking chronically, but rather because of the nature and size of the appliances that would be regulated under the proposed rule.

Response: EPA views the chronic leak reports as necessary to supporting the Agency's efforts to reduce emissions of refrigerants from appliances. EPA does not view an increase in chronic leak reporting for appliances below 50 pounds negatively because the Agency wants to ascertain issues with refrigerant-containing appliances and better understand why such appliances at all charge sizes are chronically leaking. For example, as the commenter stated some appliances with small charge sizes lose their full charge very quickly, and the Agency wants to know why these appliances are leaking at such a high rate and what owners or operators are doing to repair the leaks to ensure that the appliances are no longer chronically leaking. The Agency disagrees that these appliances would not be considered chronically leaking because of their size or the way they are serviced. EPA also notes that the commenter's description of servicing a small appliance is concerning because the overcharging of an appliance may lead to additional issues with leaks. It is unclear from the commenter's description why a technician would potentially overcharge a system simply to avoid having to carry partial cylinders. Regardless of the commenter's example, any appliance leaking more than 125 percent of its full charge in one year is subject to the final rule's chronic leak reporting.

f. Retrofit and retirement plans

EPA is finalizing aspects of the proposed retrofit and retirement plan provision, with modifications after consideration of the comments and information received on the proposed rule. EPA is requiring the development of retrofit and retirement plans for refrigerant-containing appliances that contain HFCs and certain substitutes for HFCs, where leaks cannot be repaired, or when an owner or operator chooses to retrofit or retire an appliance rather than repair a leak. As further discussed in section IV.A.2 of this preamble, EPA is not finalizing the aspect of the proposed definition of retrofit that would require that a retrofit be to a lower-GWP alternative than the original refrigerant; thus, the final rule allows the retrofit of refrigerant-containing appliances to a refrigerant that does not have a lower-GWP than the original refrigerant. This determination is based on consideration of the potential compliance burden of requiring retrofits to lower-GWP refrigerants for certain appliances subject to the leak repair provision. However, the Agency encourages owner/operators to choose lower-GWP options when considering retrofits.

The final rule provides the details on the timing for creating a retrofit or retirement plan for covered refrigerant-containing appliances, and what must be contained in a retrofit or retirement plan. EPA is requiring that a retrofit or retirement plan be created within 30 days of certain scenarios. The Agency understands this timing is sufficient for an owner or operator to either attempt to repair the leak with all the necessary requirements as described in section IV.C.3.b of this preamble or make a business decision to directly begin the retrofit or retirement process. It is necessary to cap this timing requirement to minimize emissions from leaks in the case where an owner or operator fails to take any action after finding that their applicable refrigerant-containing appliance is leaking above the applicable leak threshold. After 30 days, the owner or operator must begin developing a retrofit or retirement plan. The following scenarios describe when a retrofit or retirement plan must be developed:

- A refrigerant-containing appliance is leaking above the applicable leak rate, and the owner or operator intends to retrofit or retire the appliance rather than repair the leak;
- A refrigerant-containing appliance is leaking above the applicable leak rate, and the owner or operator fails to take action to identify or repair the leak; or
- A refrigerant-containing appliance is continuing to leak above the applicable leak rate after an attempted leak repair and verification testing.

EPA is requiring that the retrofit or retirement plan include information regarding the location of the appliance, characteristics of the appliance, a procedure for how the appliance will be converted to accommodate a different refrigerant (if the appliance is being retrofitted), plans for the disposition of any recovered refrigerant and the appliance (if the appliance is being retired), and a schedule for the completion of the appliance retrofit or retirement. Characteristics of the appliance that will be retrofitted or retired include the type and full charge of the refrigerant used in the appliance, and for retrofitting, the type and full charge of the refrigerant to which the appliance will be retrofitted. In describing how the appliance will be retrofitted, the owner or operator must include an itemized procedure for converting the appliance to a different refrigerant, including changes required for compatibility. This also includes any changes for compatibility that relate to safety considerations to ensure the safety of technicians and consumers when converting an appliance to a different refrigerant, which further serves one of the purposes identified in subsection (h)(1). EPA is also requiring that the retrofit or retirement plan must include information on how any recovered refrigerant is being dispositioned. In the case of retiring an appliance, the retirement plan needs to include how the appliance is being disposed of. EPA is establishing that the retrofit or retirement plan must include a schedule for completion of the retrofit or retirement and, unless additional time is granted, that the schedule may not exceed one year of the plan's date (not to exceed 12 months from when the plan was finalized). Owners or operators may request relief from the provisions of a retrofit or retirement plan if they are able to prove that an appliance is no longer leaking above the applicable leak rate within 180 days of creating the plan and they agree to repair all identified leaks within one year of the plan's date. The owner or operator is required to submit specified information to EPA, including information regarding leaks in the appliance, descriptions of the work completed/to be completed, and more, per 40 CFR 84.106(h)(5)(ii).

For IPR equipment, extension requests are allowed in cases where requirements or other applicable federal, state, local, or tribal regulations make it impossible to complete the retrofit or retirement within one year. In this case, owners or operators could be permitted additional time to the extent needed to comply with the applicable regulations. EPA is also establishing a provision that allows for extensions to be requested for IPR equipment if the equipment is custom-built and the supplier of the appliance or one of its components has quoted a delivery time of more than 30 weeks. In such cases, the appliance or component must be installed within 120 days of receipt. If additional time is needed, the owner or operator would need to submit a request for the additional time to EPA. Further, extensions can be requested to complete a retrofit or retirement if the IPR equipment is located in an area subject to radiological contamination or if shutting down the appliance will directly lead to radiological contamination. In this case, EPA is allowing additional time to the extent necessary to complete the retrofit in a safe working environment. EPA did not propose and is not finalizing extensions specifically applicable to federally owned equipment (see, *e.g.*, the provisions at 40 CFR 82.157(i)(3)). EPA discussed in the proposal that these circumstances can be addressed under the other extension provisions.

As noted in the proposal, these requirements reduce emissions by capping the amount of time an appliance can remain in operation when it is known to be leaking above the leak rate threshold. Developing the retrofit or retirement plan is a key process in ensuring that each step of the plan is successfully performed such that releases of HFCs are minimized and the reclaiming of the HFCs can be maximized. Owners or operators may choose to retrofit or retire a leaking appliance rather than repair a leak, or, in some situations, may be required to retrofit or retire the appliance if successful leak repair cannot be achieved and verified. The requirements also further serve the purposes of minimizing releases and maximizing the reclaiming of HFCs, as proper retrofit or retirement of a leaking appliance helps ensure that further HFC emissions from such equipment are mitigated. Additionally, in the process of retrofitting or retiring an appliance, the refrigerant that was remaining in the leaking appliance must be recovered and could then subsequently be reclaimed.

Comment: Several commenters provided recommendations for EPA's proposal regarding retrofit and retirement plans. Two commenters requested that retrofit and retirement plans include a provision to retrofit an appliance with a lower-GWP refrigerant. Another commenter suggested EPA allow for a repair plan for IPR appliances to ensure continued operation of industrial manufacturing processes that rely on IPR systems to continue to operate while the owner or operator pursues repair of the appliance. Specifically, the commenter stated that it is unfeasible to retrofit IPR appliances with evaporator temperatures below -50 °C (-58 °F) because low-temperature appliances are typically not retrofitted and have limited lower-GWP options, as demonstrated by the 2023 Technology Transitions Rule exclusion of these systems. The commenter stated that the design and replacement of these systems may take several years, and a repair plan should allow the facility to continue operations while taking the necessary steps to address the leaks.

Response: EPA is finalizing aspects of the proposed retrofit and retirement plan provision, with modifications after consideration of the comments and information received on the proposed rule. In the final rule, the Agency is not requiring that retrofit plans must transition to lower-GWP refrigerants (see section IV.A.2 of this preamble). The decision of what type of retrofit is appropriate when a refrigerant-containing appliance cannot be repaired is the decision of the owner/operator; however, EPA encourages owners or operators to retrofit appliances to lower-GWP refrigerants. It is also up to the discretion of the owner or operator to decide if an appliance can be retrofitted or retired and replaced when an owner/operator cannot repair a leak below the applicable threshold within the final rule's provided leak repair timeframe. While some commenters suggest the Agency require retrofitted appliances to use lower-GWP refrigerants, EPA has determined that requiring the use of lower-GWP refrigerants may pose a compliance issue with the provision. For certain appliances with limited lower-GWP alternatives, the proposal's definition of retrofit would have limited said appliances from having the option to retrofit. As previously discussed in this section, the retrofit and retirement provision reduces emissions of HFCs and covered substitutes by capping the amount of time an appliance can remain in operation when it is known to be leaking above the leak rate threshold. Limiting certain appliance owners to one method of compliance (*i.e.*, retirement) would not further the purpose of this rule to reduce emissions from equipment and may increase non-compliance with the provision in certain instances (*e.g.*, an owner or operator is unable to retrofit an appliance with a lower-GWP refrigerant). EPA notes that not all appliances are fit to be retrofitted; however, the proposal's definition of retrofit may have been too restrictive in how appliances could be retrofitted to comply with the leak repair provisions in the final rule.

EPA disagrees with one commenter's request to allow for a repair plan for appliances incapable of repairing leaks in the final rule's specified timeframe. The continuous operation of an appliance that is leaking above its applicable leak rate threshold is directly opposed to reducing emissions and further serving the purposes outlined in subsection (h)(1). The commenter's suggested repair plan would not adequately address leaks in a timely manner in order to minimize the release of refrigerants. and continued operation of the appliance would necessitate the addition of more refrigerant that would also be at risk of being emitted. The final rule provides 12 months from the approval of a retrofit or retirement plan to retrofit or replace a system. There is also the ability to extend the implementation of an owner or operator's retrofit or retirement plan by one year if certain conditions are met. The Agency finds this timing to be sufficient and notes that the commenter did not provide sufficient evidence to prove that these specific IPR systems take an exceptionally long time to replace. In regard to the commenter's concerns on retrofitting not typically being an option for certain low-temperature IPR systems due to limited lower-GWP options, EPA reiterates that changes to the definition of retrofit should permit the retrofit of these appliances. This change should provide owners and operators with the option to retrofit or retire an appliance, even under the circumstances described by the commenter.

Comment: One commenter stated that 30 days is inadequate to develop a retrofit and retirement plan for complex appliances like supermarket systems. The commenter claimed that multiple repair attempts may be necessary to effectuate a repair and incorrectly stated that owner/operators would not have the opportunity to conduct multiple repair attempts and would therefore be pushed into developing a retrofit and retirement plan. Further, the commenter asserted that there is uncertainty on the timeframe to complete retrofit or retirement plans because the approval of extension requests is at EPA's discretion. For these reasons, the commenter suggested EPA extend the time to create a retrofit and retirement plan to 90 days to allow for sufficient development of the plan. Additionally, the commenter suggested EPA could adopt retrofit or retirement planning if an appliance has two or more leaks during which a certain percentage of the full charge is lost in a calendar year. The commenter also proposed an alternative relief provision if the owner/operator has a zero percent leak rate for the first 180 days of the following calendar year.

The commenter also asserted that the rule exceeds EPA's authority under the AIM Act because it would undermine key flexibilities intended by Congress in phasing down HFCs. The commenter asserted that the AIM Act does not confer limitless authority to EPA to impose the expansive and unnecessarily burdensome leak detection and repair requirements set forth in the proposed rule. The commenter also claimed that subsection (h) does not authorize the Agency to compel retrofit of existing refrigeration appliances with lower-GWP refrigerants or to require system retrofit or retirement in situations where leaks cannot be addressed under the narrow leak repair timeline in the final rule. The commenter further stated that finalizing these requirements would contravene the congressional intent that EPA establish a market-based mechanism to phase down HFCs in an economically efficient way and that existing systems be exempt from technology-forcing regulations, which are only authorized under subsection (i).

Response: The Agency disagrees that 30 days is not enough time to prepare a retrofit or retirement plan. Owners or operators will typically know during the leak repair process whether they will retrofit or retire an appliance. Some owners or operators might also prefer to opt into a retrofit or retirement plan in lieu of attempting a leak repair or if the appliance is continuing to leak above the applicable leak rate after an attempted leak repair and verification testing. The Agency clarifies that the leak repair provision does not bar owner/operators from conducting multiple repair and verification test attempts within the leak repair timeline described in section IV.C.3.b of this preamble, as the commenter argued. The retrofit or retirement requirement in this final rule does not begin until an appliance is unable to be repaired and brought below the applicable leak rate threshold in the allotted leak repair timeframe, which may be as long as 180 days for commercial refrigeration. Additionally, the required information (40 CFR 84.106(h)(2)) for retrofit or retirement plans should already be readily available to the owner or operator. EPA clarifies that retrofit or retirement plans are not required to be submitted to the Agency; the plans must be retained as record on the site of the refrigerant-containing appliance that can be made readily available for inspection by EPA. Therefore, there is no uncertainty with whether the

Agency would accept a retrofit or retirement plan, because it is not required to be reported to the Agency unless the owner or operator is requesting relief from a retrofit or retirement plan or the owner or operator is requesting an extension in time to complete the retrofit or retirement of an appliance. Further, the Agency is providing clarity in the final rule that a retrofit or retirement plan is necessary when:

- A refrigerant-containing appliance is leaking above the applicable leak rate, and the owner or operator intends to retrofit or retire the appliance rather than repair the leak;
- A refrigerant-containing appliance is leaking above the applicable leak rate, and the owner or operator fails to take action to identify or repair the leak; or
- A refrigerant-containing appliance is continuing to leak above the applicable leak rate, even after attempted leak repair(s) and verification testing.

EPA also disagrees with the commenter's suggested retrofit or retirement plan because it would inadequately address emissions from appliances that are leaking above the applicable leak rate threshold. Allowing for an end-of-year calculation to determine whether an appliance is leaking above the applicable threshold, cannot be repaired, and requires retrofit or retirement would lead to an indeterminant amount of refrigerant being emitted. The commenter's proposal would not be a well-suited approach compared to the provision EPA proposed and is finalizing in this action to minimizing releases from equipment and maximizing reclamation when refrigerant-containing appliances are retrofitted or retired. Additionally, the commenter's alternative to the relief provision is not reasonable, as having a zero percent leak rate in the first 180 days of the following calendar year could cause the relief provision to fall well outside the timeframe for retrofit and retirement plans. The Agency clarifies that retrofit and retirement plans are to be *completed* within 12 months of submitting the retrofit and retirement plan, unless an extension as outlined in 40 CFR 84.106(i) applies. The provision is not based on the calendar year; rather, the timeframe is based on the owner/operator not being able to repair leaks below the applicable threshold within the allotted time for leak repair and thus needing to develop a retrofit or retirement plan. Specifically, the timeframe for completion of a retrofit or retirement plan begins when an owner or operator submits their retrofit or retirement plan to the Agency. Owners or operators can apply for relief from their retrofit or retirement plan within 180 days of the plan's start date if they can prove the appliance is repaired and no longer leaking above the applicable leak rate. EPA also clarifies that the Agency is not requiring appliances to have a zero percent leak rate, because this may be unreasonable for certain appliances at certain charge sizes. Owner/operators must simply ensure that an appliance is leaking below an appliance's applicable leak rate threshold to apply for relief from their retrofit or retirement plans.

With respect to the comments on EPA's legal authority, EPA notes that it is not further addressing the comments on whether it has legal authority to require that retrofits use a lower-GWP refrigerant because it is not finalizing such a requirement in this action. EPA disagrees with the comments that subsection (h) does not authorize the Agency to require system retrofit or retirement in situations where leaks cannot be addressed under the narrow leak repair timeline, and with those that claim the requirement contravenes congressional intent. EPA interprets its regulatory authority under subsection (h)(1) to include authority to establish requirements related to the prevention and repair of leaks for equipment containing HFCs or substitutes for HFCs, as such requirements control practices, processes, and activities regarding the servicing, repair, disposal, or installation of equipment. These requirements also implement one of the purposes identified in subsection (h): minimizing releases of HFCs from equipment. The leak detection and repair requirements finalized in this rule, including the retrofit and retirement requirements, fit squarely within this grant of authority. The retrofit or retirement requirements apply when the leak has not been repaired consistent with the regulatory requirements and are designed to ensure that additional action is taken to address such leaks and limit the ongoing release of the refrigerant to the environment, thus serving the purposes identified in subsection (h) of maximizing reclamation and minimizing release of HFCs from equipment. The types of activities taken as part of retrofit and retirement- such as modifications to the appliance needed to convert it to a new refrigerant, switching the refrigerant from the old to the new refrigerant, and repairing all identified leaks for a retrofit, or actions to retire and dispose of the appliance in the case of a retirement- are typical examples of the kinds activities related to the servicing, repair, installation, or disposal of equipment that Congress authorized EPA to control through regulations under subsection (h).

EPA also disagrees with the commenter's characterization of Congressional intent, as that characterization ignores the role of subsection (h) in the overall statutory scheme. The AIM Act contains a variety of provisions that are targeted at addressing different aspects of regulated substances. This rule does not address the Act's phasedown provisions, nor does it address the technology transition provisions; thus, comments directed at those provisions are beyond the scope of this rulemaking and require no further response. However, to the extent that the comment suggests that these aspects of the AIM Act preclude EPA from issuing regulations that subsection (h) directs it to issue, EPA disagrees. Rather, EPA views the Act as providing separate and distinct regulatory authorities, which can be implemented in ways that reinforce and complement one another. EPA also disagrees with the commenter's implication that technology-forcing regulations are only authorized under subsection (i) of the Act. The plain text of the Act includes no such limitation. Interpreting the Act to include one would limit EPA's ability to fulfill the direction and achieve the purposes stated in subsection (h). While EPA acknowledges that subsection (i)(7)(B), entitled "Applicability of Rules," includes the limitation that a "rule promulgated under this subsection shall not apply … except for a retrofit application, equipment in existence in a sector or subsector before December 27, 2020," that restriction expressly applies only to rules issued under subsection (i); it does not apply to rules promulgated under subsection (h), such as this rule. In fact, subsection (h) includes its own provision addressing inapplicability for regulations under (h) at (subsection (h)(4) entitled "Inapplicability"). That provision does not mention any limitation on application of the rules to existing equipment. If Congress had intended for such a limitation to apply under subsection (h), it is reasonable to expect that legislators would have explicitly included it in this provision, as they did in subsection (i)(7)(B).

Regarding the commenter's assertion that the AIM Act does not confer limitless authority to EPA to impose the proposed "expansive" and "unnecessarily burdensome" leak detection and repair requirements, the Agency does not view the AIM Act as conferring limitless authority. Instead, EPA concludes that in this rule the requirements that are being finalized are well within the scope of authority provided by the AIM Act and are consistent with subsection (h), for the reasons described previously in this response and elsewhere in this final rule. EPA disagrees with the characterization of this rule as "unnecessarily burdensome" for the reasons described in section IV.C.2 of this preamble. Further, the Agency has explained why these requirements are appropriate for serving the purposes under subsection (h) as described throughout this section of the preamble.

Comment: One commenter recommended that EPA align the requirements for retrofit or retirement plans with the CAA section 608 regulations to reduce uncertainty and compliance costs. The commenter also suggested that EPA consider merging the entire leak detection and repair programs under CAA section 608 and subsection (h) of the AIM Act into one regulation to help streamline the respective requirements and avoid confusion in compliance on the part of owners and operators.

Response: EPA clarifies that this specific provision and many other leak repair provisions in the final rule largely aligned with regulations under CAA section 608. When creating this final rule, EPA looked to align the provisions with the CAA while also building on the CAA regulations where appropriate (*e.g.*, changing the charge size threshold to 15 pounds for leak repair). Additionally, EPA notes that the leak repair rules under the CAA and this final rule were promulgated under two separate statutory authorities, and that the Agency did not propose to reopen the requirements under the CAA as part of this rulemaking. Thus, the Agency is not merging the requirements in the way the commenter suggest in this action. However, as previously stated we have evaluated how to make the leak repair provisions under the CAA and AIM Act streamlined and understandable. EPA disagrees that this final rule will cause confusion for owners and operators. As stated previously, this final rule is largely aligned with the leak repair requirements under CAA section 608.

g. Recordkeeping and reporting

EPA is requiring recordkeeping requirements for refrigerant-containing appliances with a charge size of 15 pounds or more of a refrigerant containing an HFC or a substitute for an HFC with a GWP above 53 under subsection (h) that are similar to those at 40 CFR 82.157(l). Where EPA is establishing requirements for recordkeeping, the record must be maintained for three years in either paper or electronic format. An owner or operator may contract out the record generation responsibilities but retains ultimate liability for compliance and must be able to access these records electronically or in hard copy from the facility where the appliance is located. All recordkeeping requirements can be found in 40 CFR 84.106(l). These records are the primary means for the facility to demonstrate compliance with the leak repair requirements, and EPA will review them when evaluating compliance. EPA will access these records in various ways, including, but not limited to, on-site review of the records or requesting them via an information request. In general, EPA is establishing the following recordkeeping requirements for owners and operators under subsection (h):

- Maintain records documenting the full charge of appliances;
- Maintain records, such as invoices or other documentation showing when refrigerant is added or removed from an appliance, when a leak inspection is performed, when a verification test is conducted, and when service or maintenance is performed;
- Maintain retrofit and/or retirement plans;
- Maintain retrofit and/or extension requests submitted to EPA;
- If a system is mothballed to suspend a deadline, maintain records documenting when the system was mothballed and when it was brought back on-line (*i.e.*, when refrigerant was added back into the appliance or isolated component of the appliance);
- Maintain records of purged and destroyed refrigerant if excluding such refrigerant from the leak rate;
- Maintain records to demonstrate a seasonal variance; and
- Maintain copies of any reports submitted to EPA under the reporting requirements in this action.

EPA is also requiring reporting and recordkeeping for refrigerant-containing appliances with a charge size of 15 pounds or more of a refrigerant containing an HFC or a substitute for an HFC with a GWP above 53 under subsection (h) that are similar to those at 40 CFR 82.157(m). The reporting requirements include notifications to EPA that include specified information when:

- The owner or operator is seeking an extension to complete repairs;
- The owner or operator is seeking an extension to complete a retrofit or retirement plan;
- The owner or operator is seeking relief from the obligation to retrofit or retire an appliance;
- An appliance leaks 125 percent or more of the full charge in a calendar year;
- The owner or operator is excluding purged refrigerants that are destroyed from annual leak rate calculations for the first time.

Additional detail on these recordkeeping requirements is available at 40 CFR 84.106(l). The recordkeeping and reporting requirements in this action for ALD systems are described in section IV.D.2. of this preamble.

As discussed in the proposal, the recordkeeping and reporting requirements support compliance with the leak repair provisions under the final rule for applicable refrigerant-containing appliances that contain HFCs or certain substitutes for HFCs as a refrigerant. For example, the requirements will control recordkeeping and reporting practices, processes, or activities for servicing and repair that involves HFCs or a substitute for an HFC. As discussed in section II.B. of this preamble, EPA's authority to require recordkeeping and reporting under the AIM Act is also supported by section 114 of the CAA, which applies to the AIM Act and rules promulgated under it as provided in subsection (k)(1)(C) of the AIM Act. The recordkeeping and requirements related to the leak repair requirements under this rulemaking are applicable to the full range of appliances that are subject to the leak repair provisions, including those containing at least 15 pounds of refrigerant with limited exemptions, as described in section IV.C.2.b of this preamble for certain appliances. The recordkeeping and reporting requirements provide critical information about whether required actions were taken and are part of the suite of compliance tools included in this rule. Compliance with the overall leak repair requirements is intended to minimize the release of refrigerants, and the Agency considers these recordkeeping and reporting requirements necessary to readily assess compliance. Records that demonstrate noncompliance or are incomplete may be used for enforcement purposes. The requirements are informed in part by EPA's consideration of its experience implementing similar regulations under CAA section 608 at 40 CFR 82.157 and the recordkeeping and reporting requirements that have been used to ensure compliance with those provisions.

Furthermore, EPA notes that there are existing recordkeeping requirements at 40 CFR 82.156(a)(3) for technicians evacuating refrigerant from appliances with a full charge of more than 5 and less than 50 pounds of refrigerant for purposes of disposal of that appliance. These records are used to assess technicians' compliance with the disposal requirements for appliances between 5 to 50 pounds under 40 CFR part 82, subpart F and are not related to the owner/operator's compliance with the leak repair requirements. Additionally, EPA notes that the bulk of the appliances covered by the recordkeeping requirements at 40 CFR 82.156(a)(3) are residential air conditioning appliances, which are exempt from the leak repair provisions in this action. EPA did not reopen any of the provisions in 40 CFR part 82 through this notice-and-comment rulemaking, and thus the Agency did not propose any changes to the referenced recordkeeping requirements. The Agency does not view these recordkeeping requirements as being in conflict with the leak repair requirements in this final rule, nor does the Agency view them as redundant.

Comment: A commenter requested clarification on the effective date of leak repair requirements as it relates to recordkeeping, considering the leak rate calculation methodologies would require existing records in order to determine the leak rate. The commenter stated that some facilities with appliances with a charge size greater than 50 pounds may not have records because of the lack of existing leak repair requirements. The commenter requests clarity on what owners or operators should do if records are unavailable to determine the leak rate and determine if repairs are required.

Response: EPA acknowledges the commenter's concerns about accurately calculating the leak rate of appliances without previously available records. As discussed in section IV.C.3.a of this preamble, because no records are required for addition of refrigerants to an appliance prior to January 1, 2026, owners or operators may calculate leak rates for appliances containing an HFC or HFC substitute with a GWP greater than 53 as though there were no additions prior to that date. For example, if an owner or operator is using the annualizing method for the first addition of refrigerant in calendar year 2026, the second term would be 365/365 (or "1"). For subsequent additions the second term would be 365 divided by the shorter of the number of days since refrigerant was last added or 365. Alternatively, if an owner or operator is using the rolling average method for the first addition of refrigerant in calendar year 2026, the numerator would be the pounds of refrigerant added since the shorter of January 1, 2026, or the last successful follow-up verification test, if one was conducted in 2026. For subsequent additions the numerator is the pounds of refrigerant added since the shorter of 365 days or the last successful follow-up verification test.

Comment: One commenter requested the Agency clearly state in the regulatory text how and where required information is submitted electronically so the regulated community knows where and how to transmit the required information.

Response: EPA is creating a web-based platform for owners or operators to submit requests for extensions, chronic leak reports, and other reportable materials to the Agency. The Agency intends to provide additional information and guidance on reporting at https://www.epa.gov/climate-hfcs-reduction/managing-use-and-reuse-hfcs-and-substitutes.

Comment: One commenter suggested that recordkeeping and reporting requirements should not apply to residences, families, and landlords unless a threshold of several owned units is surpassed.

Response: As previously discussed in section IV.C.2 of this preamble EPA is exempting appliances in the residential and light commercial air conditioning and heat pump subsector from the leak repair provisions of the final rule and those appliances are not subject to recordkeeping and reporting. EPA did not propose and is not finalizing any recordkeeping and reporting requirements for homeowners or landlords using air conditioning appliances in this subsector.

D. How is EPA establishing requirements for the installation of automatic leak detection systems?

EPA is finalizing aspects of the proposed ALD requirements, with modifications after consideration of the comments and information received on the proposed rule. EPA is finalizing that ALD systems must be installed for new and certain existing refrigerant-containing appliances in the IPR and commercial refrigeration subsectors with a charge size of 1,500 pounds or more. This provision applies to these refrigerant-containing appliances in the IPR or commercial refrigeration subsector that contain an HFC or a substitute for an HFC with a GWP above 53. In the proposal, new refrigerant-containing appliances installed after 60 days of the publication of the final rule in the **Federal Register** were required to install an ALD within 30 days of appliance installation. EPA proposed that existing refrigerant-containing appliances installed before 60 days after the date of publication of the final rule in the **Federal Register** were required to install an ALD system by one year after the date of publication of the final rule in the **Federal Register**. EPA is finalizing that beginning January 1, 2026, new refrigerant-containing appliances above the 1,500-pound charge size threshold in the IPR and commercial refrigeration subsectors are required to install an ALD system as a part of the overall appliance installation, either during the installation of the new appliance or within 30 days from when the new appliance is installed. Generally depending on the type of ALD system, it may be more practicable to install an ALD system during the appliance installation. The compliance date for the installation of ALD systems is over one year later than proposed to provide additional time for new appliance owners to procure and install ALD systems because additional time may be needed to secure a contractor or technician to install the ALD system, or there may be unforeseen delays in acquiring an ALD system. For existing IPR and commercial refrigeration installed on or after January 1, 2017, and before January 1, 2026, EPA is requiring that ALD systems be installed by January 1, 2027. The change to the compliance date and applicability for existing IPR and commercial refrigeration appliance above 1,500 pounds was informed by commenters and further considerations made by EPA to ease potential supply issues and facilitate compliance with this provision. The compliance date has been extended by one year (*i.e.*, January 1, 2027) to allow additional time for existing appliances to comply with the provision, and the applicability of appliances affected by this provision has been altered to ensure that a proper supply of ALD systems is available to owners and operators. Further discussion of this change can be found later in this section.

As discussed in the proposal, ALD systems serve the purposes described in subsection (h)(1) to control any practice, process, or activity regarding servicing, repair, or installation of such appliances, which involve a regulated substance or a substitute for a regulated substance. When an ALD system detects a leak in a refrigerant-containing appliance covered by this rule, an owner or operator of the appliance is required to either perform practices, processes, and/or activities to determine whether service or repair of the appliance is necessary (*i.e.*, calculating a leak rate and assessing it compared to the applicable leak rate for the type of appliance) or, alternatively, preemptively repair the leak (*i.e.*, before adding refrigerant and calculating the leak rate). The Agency is explicitly encouraging preemptive repair of a leak as a compliance option to avoid the need to add refrigerant to an appliance with a known leak (which would otherwise generally be necessary to calculate the leak rate and determine if the applicable leak rate is exceeded). If the preemptive repair is being used as a compliance option, it must occur within 30 days (or 120 days where an industrial process shutdown is necessary) of the alert. Taken together, these requirements are expected to facilitate prompt repair of leaks, which further helps minimize releases of regulated substances from equipment and maximize the amounts of regulated substances remaining in the equipment for eventual recovery and reclamation.

In the case of preemptive repair, this compliance option provides the opportunity to repair an appliance that is known to be leaking prior to the addition of refrigerant. When refrigerant is added to an appliance that underwent preemptive repair, a leak rate calculation is still required after the addition of refrigerant. Owners or operators choosing to preemptively repair identified leaks per 84.108(h)(2) are not required to conduct an initial or follow-up verification test at the time of leak repair, unless the calculated leak rate performed after refrigerant is added is above the applicable leak rate. If the refrigerant-containing appliance is found to be leaking above the applicable leak rate threshold after preemptive repair the full suite of leak repair requirements (*e.g.,* initial and follow-up verification tests) will still apply. EPA clarifies that owners or operators using the rolling average method must continue to use the date of the last successful follow-up verification test or 365 days, whichever is shorter, to calculate the leak rate. If multiple preemptive repairs (and associated refrigerant additions) are conducted within a time frame since the shorter of the last successful follow-up verification test or 365 days, the cumulative pounds of refrigerant added since the last successful follow-up verification test, or 365 days should be used to calculate the leak rate. For example, over the period of six months an owner or operator's ALD alerts them of a leak three times. The owner or operator, each time the ALD alarm alerts them, preemptively repairs a refrigerant-containing appliance and calculates the leak rate using the rolling average method. For the first refrigerant addition the owner or operator uses the number of pounds added since the shorter of 365 days or the last successful follow-up verification test. For subsequent leaks detected by an ALD system, the owner or operator would use the cumulative amount of refrigerant added since the shorter of 365 days or the last successful follow-up verification test. If the cumulative amount of refrigerant added causes the refrigerant-containing appliance to exceed its applicable leak rate, then the owner or operator must follow through with the full suite of leak repair requirements.

The preemptive repair actions can be considered in determining whether the suite of leak repair requirements triggered by the exceedance of the applicable leak threshold have been satisfied, but the owner or operator of the appliance would still need to ensure that the leaks had been repaired according to the definition of repair and that the other requirements in 40 CFR 84.106 (*e.g.*, initial and follow-up verification tests, leak inspections (where applicable) and related recordkeeping) had been met. The timing of the leak repair requirements is the same as described in section IV.C.3.b of this preamble. If an owner or operator finds that the leak rate for a refrigerant-containing appliance is above the applicable leak rate threshold the owner or operator must conduct an initial verification test in the 30-day timeframe for preemptive repair. A follow-up verification test must be conducted within 10 days of the successful initial verification tests and leak inspections for portions of the refrigerant-containing appliance not monitored by an ALD system would begin after the date of a successful follow-up verification test.

As previously discussed in section IV.C.3.d of this preamble, EPA considers the leak inspections that are being codified at 40 CFR 84.106(g) and the requirements related to ALD systems that are for codification at 40 CFR 84.108 to be separate. However, in certain circumstances the use of ALD systems that meet certain requirements under the 40 CFR 84.108 is a compliance option that may be used in lieu of quarterly or annual leak inspections. Further, the regulations under CAA section 608 include provisions where an owner or operator of a covered appliance with ODS refrigerants may choose to use an ALD system in place of performing regular leak inspections as a part of the leak repair provisions at 40 CFR 82.157. Nothing in this final rule changes the requirements related to ALD systems under CAA section 608 for equipment containing only ODS refrigerants. In other words, an owner or operator of an appliance that uses ODS-containing refrigerants will continue to be required to meet any and all requirements under 40 CFR 82.157 for that appliance, including if they choose to use an ALD system to comply with requirements under 40 CFR 82.157.

EPA understands that for reasons other than this rule, ALD systems are already in use to a certain extent. For example, some owners or operators may already use ALD systems to serve as an early warning system for detecting and repairing leaks. Some owners or operators may choose to install ALD systems from an economic perspective as early detection and repair of leaks can avoid costs of replacing the released refrigerant and operating equipment at suboptimal levels and/or the loss of perishable products due to failure to maintain required cooling. Further, the Agency is aware of safety standards that apply when using certain HFCs and/or substitutes for HFCs that have been classified as lower flammability. Lower flammability refrigerants in this context are those that are classified by ASHRAE as A2L refrigerants.[71] UL Standard 60335-2-40 currently requires the use of leak detectors for electrical heat pumps, air conditioners and dehumidifiers containing A2L refrigerants.[72,73] Under that standard, leak detectors that detect pressure loss are required in cases that the prescribed A2L charge limit is exceeded (which is typically around four pounds for permanently installed applications). That standard also prescribes that refrigerant leak detectors be installed at the factory for applicable appliances and have factory established set points for detection to avoid potential buildup of concentrations of flammable refrigerants.

[71] ASHRAE Standard 34–2022 assigns a safety group classification for each refrigerant which consists of two alphanumeric characters (*e.g.*, A2 or B1). The capital letter indicates the toxicity class (“A” for lower toxicity) and the numeral denotes the flammability. ASHRAE recognizes three classifications and one subclass for refrigerant flammability. The three main flammability classifications are Class 1, for refrigerants that do not propagate a flame when tested as per the ASHRAE 34 standard, “Designation and Safety Classification of Refrigerants;” Class 2, for refrigerants of lower flammability; and Class 3, for highly flammable refrigerants, such as the hydrocarbon refrigerants. ASHRAE recently updated the safety classification matrix to include a new flammability subclass 2L, for flammability Class 2 refrigerants that burn very slowly.

[72] UL. 2019. “Understanding UL 60335-2-40 Refrigerant Detector Requirements.” *https://www.ul.com/news/understanding-ul-60335-2-40-refrigerant-detector-requirements*.

[73] UL 60335-2-40, 2019. Household And Similar Electrical Appliances—Safety—Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers. Third Edition. November 1, 2019.

Comment: EPA received overall support for the proposed ALD provision. One commenter stated that they strongly support any measures that will strengthen leak management practices. The commenter indicated that the greater stringency under the proposal, as compared to similar leak repair provision in CAA section 608 and the requirements ALD systems, will help detect leaks early, and thereby mitigate environmental and financials risks associated with high-volume refrigerant leakage. The commenter also stated the ALD requirements will strengthen the state refrigerant management program requirements in California and Washington. Another commenter similarly expressed support for the provision stating that ALD systems leverage technology to mitigate leakage and strengthen refrigerant management programs. Two commenters supported EPA's efforts to implement leak detection and repair requirements through the AIM Act. One of the commenters shared that their refrigerant managers have found ALD systems useful for reducing fugitive refrigerant emissions and maximizing equipment performance and energy efficiency. Another commenter in support emphasized their shared goal to reduce leakage of HFCs and measurably reduce GHG emissions in the United States. Two commenters expressed support for the use of ALD systems for commercial refrigeration and IPR appliances with a charge size of 1,500 pounds or more of HFC-containing appliances. One of the commenters asked that EPA examine any comments from manufacturers of equipment and ALD systems to ensure compliance timelines can be met without delaying the installation of new equipment or implementation of ALD systems on existing equipment.

Several commenters in support of the ALD requirements discussed how the provision would provide additional benefits and or supported existing efforts for refrigerant management. One commenter stated that ALD systems align with their commitment to environmental stewardship while maintaining the highest standards of service quality. Another commenter in support of the leak repair and ALD requirements stated the provisions would minimize releases from equipment and significantly reduce costs for businesses. The commenter provided information which estimated each supermarket in the United States leaks roughly 875 pounds of HFCs per year at a rate of two parts per million (ppm) to 182 ppm, and all supermarkets in the United States leak emissions equivalent to burning 49 billion pounds of coal. As discussed in section IV.C.3, several commenters supported the ALD provisions as the provisions further apply a LRM approach to HFC management.

Conversely, one commenter stated the proposed ALD requirements are not consistent with part 82 ODS requirements, where ALD systems are a compliance option, and should be amended to align with those requirements. As further discussed in section IV.C.3.f, another commenter asserted that the AIM Act does not confer limitless authority to EPA to impose the expansive and unnecessarily burdensome leak detection and repair requirements set forth in the proposed rule.

Response: EPA is finalizing required use of ALD systems for a specific set of IPR and commercial refrigeration appliances with a charge size of 1,500 pounds or more. The Agency acknowledges comments in support of the ALD provision and agree with commenters on the environmental benefits, reduction of financial risks, and fugitive emissions associated with ALD requirements. EPA also agrees with commenters that the ALD provision will strengthen refrigerant management programs in states which require ALD. EPA acknowledges the analysis of the amount emissions avoid by the ALD provision. The Agency also agrees with one commenter's statement that this provision expands on requirements that previously applied to HFCs under CAA section 608 and will provide additional benefits from reconsidering the requirements under the AIM Act.[74] EPA acknowledges these comments and other comments in support of the provision.

The Agency acknowledges comments in support of the use of ALD in IPR and commercial refrigeration above 1,500 pounds, and that further discussion on the applicability and charge size threshold of the provisions are discussed in further depth later in section IV.D.1. The Agency did review comments from ALD system manufacturers, per the commenter's suggestion, and have responded accordingly throughout section IV.D.

The Agency disagrees with one commenter's suggestion that the Agency realign the ALD provision with part 82, subpart F and leave the utilization of ALD systems solely as a compliance option. The rules in part 82, subpart F are based on CAA section 608 which is based on a different statutory provision. While EPA concluded that it is appropriate to align many aspects of the leak repair requirements in this rule with those under CAA section 608, for certain requirements, such as this one, the conclusion to finalize a provision that is different from the requirement under CAA section 608 is also appropriate. In the time since EPA finalized that requirement in 2016, ALD systems of many types, direct and indirect, are now more widely available and the Agency now has developed a better understanding of how these various kinds of ALD systems could be used to achieve the purposes of subsection (h). As discussed previously in this section, the Agency is aware of widespread use of ALD systems used to

[74] The commenter also indicated that the requirements that applied to certain substitute refrigerants under CAA section 608 were "vacated." While actions under CAA section 608 are outside the scope of this rulemaking, the Agency notes for purposes of clarity and to avoid confusion that as discussed in greater detail in section III.C.1., EPA issued a rule in 2020 under section 608 which rescinded the 2016 extension of the leak repair requirements to appliances using HFCs and other non-exempt substitute refrigerants (85 FR 14150, March 11, 2020). Thus, it was a rulemaking by EPA that resulted in the leak repair requirements in 40 CFR 82.157 no longer applying to appliances that use substitute refrigerants. While petitions for judicial review were filed on the 2020 rule, the case is currently in abeyance and the court has not issued any final decision nor has it vacated those requirements.

comply with safety standards. The same or similar ALD systems can be utilized of the purposes of leak detection to support the ALD requirements. Moreover, ALD systems have been used for those seeking to monitor their systems for various reasons besides compliance with regulations ranging from meeting environmental stewardship goals to reducing costs of refrigerant by detecting and the subsequently repairing leaks. EPA views leaky refrigerant-containing appliances with high charges as appliances where the utilization of ALD systems is particularly valuable, given that it may take some time for an owner or operator to become aware of a leak through other methods and given the amount of refrigerant that could leak from the system while a leak is undetected. The requirements in the final rule for commercial refrigeration and IPR with a charge size of 1,500 pounds to install ALD systems will help identify leaks in such equipment earlier so that corrective action can be taken to limit the release of refrigerant from the leak. Detection of leaks in equipment is a critical step in minimizing the release of HFCs from that equipment. Thus, requiring use of ALD in systems with charges of this magnitude is one way that the regulations work to achieve the purpose identified in subsection (h)(1) of minimizing releases of HFCs from equipment. Because the HFCs that remain in the equipment can later be recovered and reclaimed, this requirement also helps serve the purpose of maximizing reclamation, also identified in subsection (h)(1).

EPA addresses the comments on legal authority in section IV.C.3.f above.

Comment: Several commenters opposed the compliance dates for new appliances. One commenter expressed concerns that the 30-day timeline for installation would be unfeasible due to current inventories, supply chain constraints, and labor shortages. The commenter suggested allowing at least a one-year compliance period for systems installed within one year of publication of the final rule. Another commenter echoed the need for an additional year after publication of the final rule and stated that installation projects are often planned months to years in advance. Both commenters stated that additional time would allow for the preparation of operating procedures and training of personnel to operate and maintain equipment. One commenter stated the proposal's compliance dates were unclear and inadequate given the anticipated demand created by the rule's provisions.

Response: EPA is finalizing a compliance date of January 1, 2026, for new IPR and commercial refrigeration systems above 1,500 pounds. In the proposal, the compliance date for new appliances was tied to the final rule's publication in the **Federal Register** and would have required the installation of an ALD system within 30 days of appliance installation. In the final rule the requirement will begin January 1, 2026, though EPA is retaining the requirement to install ALD systems within 30 days of appliance installation. The additional year should address some commenters' concerns with procurement, planning, and training of personnel. The new compliance date also allows owners or operators who may be in the process of planning appliance installation project additional time to comply with the ALD requirements. Furthermore, the compliance dates for both new and existing systems are more clearly defined which provides owners or operators additional clarity for when they will need to install an ALD system.

The Agency is finalizing that an ALD system must be installed by January 1, 2027, if the existing refrigerant-containing appliance was installed on or after January 1, 2017, and before January 1, 2026. EPA narrowed the refrigerant-containing appliances subject to this provision to those that were installed approximately 10 years ago or less because in the two categories covered in the final rule (*i.e.*, commercial refrigeration and IPR), these systems have very long useful lifetimes. The final rule's applicability cutoff date for existing systems is set to January 1, 2017, because the Agency considers that existing appliances within that timeframe to still have a majority of their useful life to operate. For example, IPR systems generally have a useful life of 20-25 years. Thus, an IPR system installed on January 1, 2017, might have an additional 10-15 years of life before the appliance would need to be replaced. Commercial refrigeration appliances at charge sizes above 1,5000 pounds have a similar useful life of about 18 years. EPA recognizes that the provision in the final rule does not have the same breadth of emissions benefits as the provision in the proposed rule, but the Agency estimates that a significant portion of existing appliances are covered by the final rule's provisions. While the Agency proposed to include all existing appliances in these categories, in this final rule, the Agency has determined to include a subset of appliances (*i.e.*, those installed since January 1, 2017) rather than all appliances and to include two of three categories of refrigerant-containing appliances (*i.e.*, IPR and commercial refrigeration) thus narrowing the number of affected appliances. Limiting the number of affected refrigerant-containing appliances should also ease concerns on the supply of ALD systems as only approximately 44 percent of existing appliances would be subject to the ALD installation requirements compared to the proposal.

Comment: Various commenters shared concerns about the compliance date for existing IPR and commercial refrigeration appliances and the supply of ALD systems. One commenter claimed that the complexity of integrating new ALD systems into an existing facility's processes necessitates more than a year to develop and construct an ALD project. The commenter stated that the compliance date would result in a single, peak-demand year, thus EPA should allow for a three-year compliance window for existing appliances. The commenter also claimed that EPA has no statutory obligation to require compliance within a shorter time period. Another commenter echoed similar concerns on technician and supply chain shortages regarding supermarket systems, stating that it would be impractical for industry to comply on time under the proposal and that compliance costs will likely be significantly higher than what EPA projects due to demand for ALD systems. The commenter stated that supermarket refrigeration systems can have 30 to 50 cases, each with an evaporator, and a large number of components which would require sensors adding to the amount of time to implement an ALD system. The commenter also stated that "off-the-shelf" may require significant modification to and thus require more time to implement. For these reasons the commenter requested the compliance date for new systems be no earlier than January 1, 2029. Another commenter suggested the compliance date for existing systems be at least two years after publication to ensure owners and operators have the needed lead time to design, procure, install, and validate ALD systems for their operations. The commenter stated that EPA may be underestimating demand in its ALD analysis and that increased demand could drive up the costs of ALD systems and slow down delivery and installation time if existing ALD manufacturers do not have the capacity to meet demand. Another commenter recommended EPA consider an exemption for commercial system operators from the proposed ALD requirements if they can prove they would transition to an ultra-low-GWP refrigerant before January 1, 2027.

Response: The Agency is finalizing a compliance timeline for existing systems later than proposed with the caveat that not all existing IPR and commercial refrigeration appliances are subject to the final rule's ALD provisions. The final rule exempts any appliance installed before January 1, 2017, from being required to install an ALD system. EPA estimates that approximately 56 percent of total existing appliances would be excluded from the ALD provision as proposed. Additionally, EPA estimates that around 25,000 existing refrigerant-containing appliances would be subject to the ALD requirements in the final rule which is significantly lower than the number of refrigerant-containing appliances subject to the ALD provision in the proposal. Owners or operators with existing refrigerant-containing appliances subject to this provision will have over two years to install an ALD system. This change will reduce the immediate demand of ALD systems and provide additional lead time for owners or operators to procure, design, and install ALD systems for their operations. The Agency notes that commenters did not provide sufficient evidence on how the state of the ALD or technician market would affect an owner or operator's ability to install an ALD system. However, as stated previously, the changes to the compliance date and applicability should ease concerns related to market shortages. Furthermore, the additional time for existing refrigerant-containing appliances subject to the ALD requirements will reduces costs associated with the demand for ALD systems as one commenter argued. Further discussion on the costs and benefits of the ALD provision can be found in section IV.B.2.

Regarding one commenter's statements on the implementation of ALD systems in supermarkets, the Agency disagrees that additional time beyond January 1, 2027, will be necessary. EPA understands that supermarket systems may be custom built or have additional complexities, however existing ALD systems can be applied to such systems even if they are considered to be "off-the-shelf" as the commenter describes. The commenter also did not provide specific information on how existing ALD systems would be inadequate in providing leak monitoring for their supermarket systems or why existing ALD systems would require significant modifications in order to be implemented. The Agency also disagrees that additional time would be needed because multiple cases and components would need to have sensors as the Agency is not prescribing the type of ALD system used by an owner or operator. To clarify, EPA is requiring an owner or operator to use either a direct or indirect ALD system to comply with the ALD requirements in this final rule. It is up to the owner or operator's discretion to decide which type of ALD system, that meets the standards described in 40 CFR 84.108, best suites their refrigerant-containing appliance. Although the Agency disagrees that either type of ALD system will be difficult to install, if the commenter finds direct ALD systems as too onerous to implement, they have the option to install an indirect ALD system to comply with the provision. Additionally, CARB's refrigerant managment program has required the use of ALD for refrigeration systems above 2,000 pounds since 2011. Certain supermarket systems are captured by this regulation and have been required to use ALD for over a decade. As previously stated, EPA views the implementation of ALD for certain appliances with large charge sizes as important to serve the purposes described in subsection (h) to minimize the release of regulated substances. For these reasons, EPA disagrees with the commenter's suggested January 1, 2029, compliance date.

With respect to the comment requesting a 3-year compliance timeframe for existing operations and further stating that EPA has no statutory obligation to require compliance within a shorter time frame, EPA responds that it recognizes that the AIM Act does not expressly establish a specific timeframe for when regulated entities need to comply with regulations under subsection (h)(1) of the AIM Act, leaving EPA discretion to determine what time period is appropriate in the context of the specific regulations promulgated. Congress identified three purposes for regulations under subsection (h)(1): maximizing reclamation, minimizing releases of HFCs from equipment, and ensuring the safety of technicians and consumers. Congress's use of the terms such as "maximize" and "minimize" in this context indicate that it intended for the regulations authorized under subsection (h)(1) to have a substantive and meaningful effect, taking into account the other statutory considerations such as whether the controls are appropriate. Because the compliance date could affect the amount of HFC emissions that occur from equipment or the amount of HFCs available for reclamation, these terms inform EPA's consideration when it is determining whether to establish a later compliance date for regulations under subsection (h)(1), and if so, what compliance date is appropriate. Thus, in establishing the compliance date for the requirements to use and install ALD systems under the final rule, EPA's objective is to allow sufficient time—but not more time than is needed—to facilitate compliance and achieve the regulatory objectives. For example, if EPA were to establish an unnecessarily long compliance date for installation and operation of ALD systems, that could result in emissions for HFCs from equipment that could have been prevented through an earlier compliance date. By the same token, establishing a compliance date that does not provide sufficient time for compliance could also have a deleterious effect on the regulations' ability to achieve these purposes if the result is that entities fail to properly comply.

The Agency acknowledges one commenter's suggestion that to provide a narrow exemption for owners or operators that could prove they would transition to a lower-GWP refrigerant-containing appliance. The Agency responds that it is not finalizing the exemption that the commenter describes because owners or operators who transition to a lower-GWP refrigerant are not necessarily exempt from the ALD and broader leak repair requirements in this final rule. The overarching applicability for refrigerant-containing appliances subject to these requirements in the final rule is whether or not the refrigerant-containing appliance uses an HFC or substitute for an HFC with a GWP greater than 53. For example, an owner or operator at the end of a refrigerant-containing appliance's useful life may transition to a lower-GWP refrigerant which contains an HFC or substitute with a GWP greater than 53 and would thus still be required to install an ALD system. In some cases, an owner or operator will transition to a refrigerant which does not contain an HFC or does not have a GWP greater than 53 (*e.g.,* R-477) and is not required to install an ALD system.

Comment: The Agency also received general comments regarding the compliance dates for the final rule's ALD provisions. One commenter, acknowledging the need for proper leak detection, expressed concern that the proposal's timelines were too aggressive and that many of the requirements and leak detection methods needed further clarification. Another commenter who generally supported the ALD provision opposed any compliance date less than three years from publication of the final rule, on grounds that it will take manufacturers and appliance owners considerable time to plan, procure, and install ALD systems. One commenter proposed that EPA could consider making the compliance date earlier. Another commenter asserted that technicians would need to be trained and re-certified to handle HFCs and work with ALD equipment. They claim ALD systems were not broadly used for any of the ODS-substitutes when the part 82 rules for HFC management under the CAA were in effect. The commenter requested EPA finalize a compliance date at least 180 days post publication of the final rule.

Another commenter claimed the proposed rule's compliance dates were impractical for large aviation and defense manufactures. The commenter stated that manufacturing military, aerospace, and space end-use products is often subject to significant oversight or control by other federal entities such as the U.S. Department of Defense and the FAA, which can include scrutiny of manufacturing processes. Further, the commenter claimed that some refrigerant-containing appliances used for IPR are uniquely designed and may not be compatible with "off-the-shelf ALD" systems, thus engineering design modifications or re-engineering could be necessary to ensure functionality of both the IPR equipment and the ALD system. The commenter requested EPA extend the compliance deadlines until 2027 for these reasons and also stated that the extension would be consistent with EPA's extension of the IPR transition date in the 2023 Technology Transitions final rule.

Response: The Agency is finalizing a new compliance date for new and existing refrigerant-containing appliances subject to the ALD provisions. New IPR and commercial refrigeration appliances that contain an HFC or HFC substitute with a GWP greater than 53 are required to install an ALD system starting January 1, 2026. EPA expects that the installation of an ALD system will be a part of the overall refrigerant-containing appliance installation, however owners or operators have 30 days after the installation of a refrigerant-containing appliance to install and ALD system. For existing refrigerant-containing appliances installed on or after January 1, 2017, owners or operators are required to install an ALD system by January 1, 2027. The changes to the compliance date should address commenter's concerns and requests for additional time (*e.g.,* 180 days, 2 years). The Agency also has provided more information on the leak detection requirements in this section and additional clarity on direct and indirect ALD systems in section IV.D.1, as requested by one commenter. EPA disagrees that the compliance timeline should be extended to at least three years after the final rule's publication. Both new and existing IPR and commercial refrigeration appliances have been given additional time to comply with the ALD requirements which allow owners or operators to necessary time to plan, procure, and install an ALD system. Further, the applicability for existing IPR and commercial refrigeration appliances has been changed to ensure supply of ALD systems is available and further facilitate compliance with the requirements. Existing IPR and commercial refrigeration appliances have over two years to install an ALD system. Furthermore, the Agency is not merging the overall compliance dates for the ALD requirements because new IPR and commercial refrigeration appliances will be able to readily integrate ALD systems. As previously stated, EPA views the ALD requirements for certain appliances with large charge sizes as important to serve the purposes described in subsection (h) to minimize the release of regulated substances. For these reasons, EPA finds the compliance dates is this final rule to be appropriate and disagree with the commenter's request for 3 years to comply with these requirements.

EPA acknowledges one commenter's proposition that the Agency could hasten the compliance date for existing equipment, However, EPA is not finalizing an earlier compliance date. The Agency does not agree that an earlier date can be met by all regulated entities for many of the reasons stated throughout this section and offered by other commenters. However, a regulated entity could choose to install an ALD system ahead of the compliance date, and there may be a variety of benefits to the regulated entity in doing so, including reduced refrigerant emissions and associated costs.

The Agency responds to one commenter's points that ALD systems were not broadly used for any of the ODS-substitutes when the part 82, subpart F rules for HFC management were in effect. The state of California has mandated the use of ALD for HFC-containing appliances with a charge size above 2,000 pounds since 2011. The commenter's insinuation that ALD use has historically been minimal is not accurate. Moreover, ALD systems have been used for those seeking to monitor their systems for various reasons besides compliance with regulations ranging from meeting environmental stewardship goals to reducing costs of refrigerant by detecting and the subsequently repairing leaks. EPA also disagrees with the commenter's assertion that technicians need training and re-certification to handle ALD systems. To the extent that this comment relates to technician certification requirements under CAA section 608, the Agency did not reopen CAA section 608 regulations through this action under subsection (h) of the AIM Act, including the technician certification requirements. Accordingly, the Agency is not addressing comments related to requirements under CAA section 608 in this final rule, as they are beyond the scope of this rulemaking and require no further response. For purposes of public information, the Agency notes that it periodically updates its test bank of questions to become a certified technician under CAA section 608 to reflect regulatory and market changes. The Agency took advanced comments on technician certification. The information the Agency received may be used to inform a future rulemaking. The Agency notes that section 608 technician certification is not intended to replace all technician education and training and anticipates that the same would be true for any future AIM Act certification program. The Agency understands that employers may provide additional onsite training and that industry organizations provide information on regulatory updates and market changes.

EPA recognizes that other federal agencies have various roles and responsibilities defined by different statutes. The Agency disagrees, however, that the ALD provisions being finalized in this action will spur significant oversight and scrutiny as one commenter asserted. The final rule requires a specific portion of IPR and commercial refrigeration appliances (*i.e.,* with charge sizes of 1,500 pounds or more) to install ALD systems. These appliances may be used by the military (*e.g.*, commissary) or at airports, for example, but these uses are not functionally different that other appliances in these same subsectors at other locations.[75] The Agency's longstanding CAA 608 regulations already includes leak repair requirements for this same equipment. The Agency acknowledges that subsection (h)(3) of the AIM Act provides that EPA "may coordinate" with certain other EPA regulations that involve "the same or a similar practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment" or reclaiming, and EPA

[75] The Agency has provided exceptions for military equipment used in deployable and expeditionary applications, as well as space vehicles.

has coordinated in many aspects of this final rule. The commenter also asserted that moving the compliance date to 2027 would align the ALD requirements in the final rule with the IPR transition in the 2023 Technology Transitions Rule. EPA has extended the compliance date to January 1, 2027, for existing refrigerant-containing appliances but clarifies that the decision was not based on an alignment with the 2023 Technology Transitions Rule. The Agency finds such an alignment in this instance to be unfounded. The 2023 Technology Transitions Rule covers new equipment and setting GWP limits. This provision under subsection (h)(1) is focused on the management of HFCs and in this case in refrigerant-containing appliances.

1. Automatic leak detection requirements

In the final rule, refrigerant-containing appliances in the commercial refrigeration and IPR subsectors with a charge size of 1,500 pounds or more with a refrigerant that contains an HFC or a substitute for an HFC that has a GWP above 53 are required to use ALD systems. The refrigerants covered are the same as for the leak repair provisions, but the full charge size cutoff for using ALD systems (*i.e.*, 1,500 pounds) is greater than that of the other leak repair provisions in this rulemaking (*i.e.*, 15 pounds). EPA acknowledges that using ALD systems for refrigerant-containing appliances that have lower refrigerant charge sizes (*i.e.*, below 1,500 pounds) may be an option an owner or operator could take so they are alerted to leaks sooner. Additionally, owners or operators may choose to install ALD systems in lieu of quarterly and annual leak inspections as previously discussed in section IV.C.3.d. As discussed in the proposal, EPA considered several potential options of the threshold for requiring ALD systems (*e.g.*, 15 pounds, 50 pounds, 500 pounds, etc.) and other thresholds used internationally and by certain states (*i.e.*, California and Washington). However, EPA is not requiring use of ALD systems for refrigerant-containing appliances with less than 1,500 pounds. As discussed later in this section, EPA also considered the supply of ALD systems when determining the applicability of appliances because adequate supply of ALD systems is required to facilitate compliance with this provision. Larger refrigeration appliances have potential to leak greater amounts of refrigerant, such that owners or operators using an ALD system to quickly detect leaks further supports the statutory purposes in subsection (h) of minimizing releases of HFCs from equipment and maximize the amount of HFC that is available for reclaiming. Moreover, EPA understands that owners or operators with larger charge size appliances (*i.e.*, above 1,500 pounds) may be more likely to have in place refrigerant management plans, routine equipment inspections, or other formal or even informal mechanisms aimed at reducing refrigerant losses for which ALD will provide additional support.

Comment: The Agency received many comments in support of the charge size threshold. One commenter expressed support for the proposed threshold given the cost burden associated with the installation of some ALD systems. Another commenter expressed support for the charge size threshold and stated that the requirements will help reduce emissions from large appliances at greater risk of leaks. One commenter in support of the provision stated that ALD systems are widely available and quickly becoming best practice for leak reduction, even for smaller systems.

Conversely, one commenter stated that EPA should change the charge size threshold to 2,000 pounds or more and asserted that the proposed ALD installation requirements would be unduly burdensome for retailers in with large refrigeration systems, particularity the retail food sector. The commenter stated that significant costs would be imposed because of equipment costs and technician fees. One commenter suggested the Agency lower the ALD charge size threshold requirements to 100 pounds per refrigerant circuit. Alternatively, the commenter suggested the ALD provision may be better suited if it was based on annual leak rates instead of charge size. For example, if an owner or operator has equipment designed to contain more than 250 pounds that has leaked more than 20 percent for 2 years, ALD would be required to be installed within 6 months. This would target problematic systems and avoid unnecessary added cost for non-leaky systems. Another commenter felt the inclusion of ALD for systems above 1,500 pounds as superfluous because the flammability of certain refrigerants below 150 GWP at high charge sizes would already necessitate ALD to comply with building safety codes. The commenter suggested that EPA defer to state and local building codes and make adjustments to determine if the requirement is necessary.

Another commenter provided a case study of a leak survey on a university campus analyzing appliances with a charge size at or below 50 pounds. They maintain that small-to-medium-sized appliances contributed an unexpectedly large portion of their refrigerant emissions and without a lower ALD charge size threshold, facility mangers would likely not allocate sufficient resources to reducing leaks from smaller equipment. The commenter stated that ALD systems are commercially available for medium-sized cooling appliances that have a charge size much lower than 1,500 pounds.

Response: The Agency is finalizing the ALD charge size threshold of 1,500 pounds for IPR and commercial refrigeration appliances that contain an HFC or HFC substitute above a GWP of 53. The 1,500 pounds threshold applies to a large group of commercial refrigeration and IPR appliances that have a high potential to leak large amounts of refrigerant. EPA considered various options in the proposal and informed by the comments finds the 1,500-charge size threshold to be appropriate. The Agency acknowledges numerous comments in support of the provision.

The Agency disagrees that the ALD charge size threshold will be overly burdensome for supermarket refrigeration systems. Supermarket systems will uniquely benefit from the inclusion of ALD as a large majority of supermarkets utilize commercial refrigeration appliances with a charge size at or above 1,500 pounds and as this commenter noted and is discussed above, have a high average leak rate of 25 percent.[76] EPA notes that the commenter did not provide adequate data to suggest that the retail food industry would be significantly burdened by the provision. EPA recognizes that there are compliance costs and benefits associated with the ALD provision, including from detecting and repairing leaks early. EPA also acknowledges that supermarkets are moving to smaller charge sizes. By including only appliances installed on or after January 1, 2017, the Agency is finalizing an approach that excludes refrigerant-containing appliances which are closer to said appliance's EOL, providing owners or operators additional flexibility. EPA also disagrees with one commenter's suggestion to require ALD based on high annual leak rates. The commenter claims that this would accurately target leak-prone appliances and reduce the burden on non-leaky equipment. EPA disagrees that this approach would function better than the final rule's inclusion of IPR and commercial refrigeration appliances with a charge size above 1,500 pounds. The commenter's approach is an interesting alternative that would use a triggering event to denote which appliances are to be subject to the requirements. However, as mentioned in the response to comments on the supermarket sector, the referenced 25 percent average leak rate would mean on average the supermarket sector typically would exceed the triggering event suggested by this commenter. While a triggering event could be considered in the future, in

[76] FMI estimates an industry average leak rate of 25 percent.

particular if EPA were to consider subsectors with lower typical charge sizes, in this instance EPA did not receive sufficient information to support this approach.

The Agency also disagrees with one commenter's assertion that the inclusion of ALD is unnecessary due to the state and local building codes requiring ALD for flammable refrigerants. If there are state and local requirements to install ALD systems that will detect refrigerant emissions, these requirements are complementary to our intent. However, these state or local requirements do not supplant our requirements or their intent. Many appliances not using a flammable refrigerant will be affected by the final rule's ALD provisions, but the requirements are applicable to all refrigerants, not just the flammable refrigerants. Furthermore, the Agency has previously acknowledged that UL Standards for A2L refrigerants requires the use of leak detection elsewhere in this section. The standards related to A2L refrigerants and state and local building codes do not nullify the authority of EPA to regulate the use of ALD systems to minimize the release of regulated substances.

With regards to the commenter that advocated for the use of ALD of medium-sized appliances because of their findings of substantial leaks from small and medium-sized appliances on a university campus, the agency recognizes that smaller systems under 1,500 pounds may still be prone to leaks and thus the Agency is also finalizing the separate leak repair requirements for refrigerant-containing appliances with 15 pounds or more of refrigerant. EPA agrees with the two commenters who stated that ALD systems are commercially available for medium-sized appliances and are becoming the best practice for refrigerant management. While EPA is not finalizing a lower threshold at this time, EPA may consider a lower charge size threshold in a future notice-and-comment rulemaking. The Agency encourages consideration of using ALD systems by the owners and operators of refrigerant-containing appliances with charge sizes of less than 1,500 pounds of refrigerant.

Comment: EPA received a several comments regarding the applicability of the proposed ALD provision. Two commenters suggested adding comfort cooling. One of the commenters specifically asked the Agency to consider including all new and existing RACHP appliances, IPR, commercial refrigeration, and comfort cooling systems with charge sizes at or above 200 pounds. The commenter stated that 200 pounds was a point of inflection for proposed GWP limits under the 2023 Technology Transitions Rule and would promote an enhanced approach over European Union standards, expediting emissions reductions in the heating, ventilation, air conditioning, and refrigeration (HVACR) industry. The commenter also expressed concerns that the 1,500-pound threshold may incentivize design modifications aimed at implementing appliance that are exempt from the ALD requirements. They further asserted that owners or operators may install multiple smaller appliances with lower charge sizes. Another commenter similarly claimed that the rule's charge size threshold and applicability of appliances would exempt a high percentage of commercial facilities from the ALD requirements and undermine the intent of the rule. The commenter suggested that EPA could consider the total cumulative mass of refrigerant being used by commercial refrigeration and IPR appliances at a facility location, rather than the mass of refrigerant being used by individual appliances. Alternatively, the commenter suggested EPA could lower the charge size threshold to 1,000 pounds per facility and lower the threshold to 500 pounds of refrigerant in an individual appliance.

Response: EPA is finalizing as proposed that the ALD requirements only apply to IPR and commercial refrigeration appliances with a charge size of 1500 pounds. EPA considered and is not establishing requiring ALD systems for all refrigerant-containing appliances above a certain charge size. Instead, after considering the opportunities to reduce leaks and thus minimize emissions, EPA decided to limit this requirement to commercial refrigeration and IPR appliances. EPA is not establishing requirements for using ALD systems for appliances used for comfort cooling. The Agency understands that refrigerant-containing appliances used for comfort cooling typically do not leak to the same degree as appliances in the commercial refrigeration and IPR subsectors. Medium (charge size of 200 to 2,000 pounds of refrigerant) and large (charge size 2,000 pounds or greater of refrigerant) comfort cooling appliances average annual leak rates of around 10 percent, while medium and large commercial refrigeration and IPR appliances have average leak rates that are around two to three times greater.[77] This is consistent with EPA's requirements for leak inspections, such that appliances used for comfort cooling would not have more frequent required leak inspections as a part of the leak repair provisions (see section IV.C.3.d). EPA previously acknowledged that in the 2016 CAA section 608 Rule (81 FR 82272, November 16, 2016) larger commercial refrigeration and IPR appliances tend to have larger annual average leak rates than comfort cooling appliances. Further, larger commercial refrigeration and IPR appliances would have a greater amount of refrigerant lost compared to comfort cooling appliances even if the leak rates were the same since these larger appliances typically have significantly larger refrigerant charge sizes. Thus, the primary benefit of early leak detection from an ALD system would not be as useful for appliances solely used for comfort cooling. However, if an appliance has a dual function (*e.g.*, IPR and comfort cooling), an ALD system would be required. For example, if the refrigerant coming off the evaporator in an industrial process were cool enough, it could be directed towards

[77] Average annual leak rates by appliance type and charge size are provided in the RIA addendum.

co-located offices or break rooms to provide air conditioning, before being routed back to the compressor(s). Such a system would provide both IPR and comfort cooling, and for purposes of this rule, an ALD system would be required.

Similarly, EPA disagrees with one commenter's suggestion to include all RACHP refrigerant-containing appliances with a charge size above 200 pounds. As discussed previously in this section, the Agency has changed the applicability of existing IPR and commercial refrigeration appliances to ensure the supply of ALD systems can meet the demand created by this final rule's requirements. Lowering the charge size threshold to 200 pounds (or any other threshold below 1,500 pounds) may create additional market disruptions and hamper the uptake of ALD systems for larger IPR and commercial refrigeration appliances, which this rule is specifically capturing, and thus diminish the potential emissions reductions for larger refrigerant-containing appliances. While the Agency encourages the use of ALD systems at any charge size, EPA does not intend to require such installation in this rulemaking. The Agency may reconsider the applicability of certain refrigerant-containing appliances at a specific charge size in a future notice-and-comment rulemaking.

EPA responds to commenter's scenario that owners or operators may circumvent the final rule's ALD provision by installing multiple smaller appliances. The Agency acknowledges it is possible that refrigerant-containing appliances that previously used 1,500 or more pounds of refrigerant could be designed to use 1,450 or less pounds of refrigerant. While EPA intends to take action if an entity is intentionally seeking to avoid compliance with the regulations, redesigning refrigerant-containing appliances to use less refrigerant is not circumventing the requirements, it is instead an alternative means to complying with the provision. Furthermore, using less refrigerant will also result in minimizing emissions, so if an owner or operator is able to install or redesign a refrigerant-containing appliance to use less refrigerant it will serve the purposes described in (h)(1) to minimize the release of refrigerants from equipment. The Agency disagrees with the request to consider the total cumulative mass of refrigerants at a facility location, as suggested by the commenter, may further complicate the ALD provision, and implicate systems that are below the 1,500-pound charge size threshold. As previously stated, the Agency is concerned with ensuring that the supply of ALD systems can meet the demand for ALD systems. The Agency did not propose and is not finalizing the charge size threshold to operate in the manner suggested by the commenter.

As a consideration in setting the threshold, EPA accounted to what extent ALD systems may already be in use and the types of equipment to which they are marketed. For example, many larger refrigeration appliances (*e.g.*, a charge size of 1,500 to 2,000 pounds or more) may already use ALD systems per certain state requirements or to reduce negative economic impacts associated with replacing leaking refrigerant. EPA also considered the availability of ALD systems for refrigeration appliances in the United States. In the TSD titled *American Innovation and Manufacturing Act of 2020 – Subsection (h): Automatic Leak Detection System* in the docket for this rulemaking, EPA assessed the market presence and number of manufacturers of ALD systems that sell to the U.S. market. EPA notes that most manufacturers make direct ALD systems, while indirect ALD systems are newer technologies on the market.[78] Since ALD systems have generally only been required for larger refrigeration appliances per certain state requirements, or are likely used in larger charge size refrigeration appliances to avoid potential economic burden associated with replacing refrigerant that has leaked, EPA anticipates that the

[78] EPA describes each type (*i.e.*, direct and indirect) of ALD system later in this section and in detail in the TSD titled *American Innovation and Manufacturing Act of 2020 – Subsection (h): Automatic Leak Detection System.*

current market presence of ALD system manufacturing is generally aligned to demand for ALD systems for larger IPR and commercial refrigeration appliances. The threshold and the change in compliance dates and applicability for this provision, accounts for the potential for an increased demand of ALD systems, where manufacturers of such systems may not be prepared for an increased demand if EPA were to finalize a lower charge size, opening the requirement for ALD systems to a larger inventory of refrigeration appliances. Taking into account existing and pending state requirements, the 2023 Technology Transitions Rule, and a likely degree of voluntary adoption of ALD systems, EPA estimates that the requirement will impact approximately 25,000 appliances between 2025 and 2027, and an average of 150 refrigerant-containing appliances per year in subsequent years. The Agency has provided these updated estimates, which differ from those in the proposal (i.e., 50,000 appliances over the year 2025 and 6,500 for subsequent years), because EPA has adjusted the applicability of existing appliances as discussed in section IV.D and in consideration that the 2023 Technology Transitions Rule has been promulgated. The updated estimates also account for new IPR and commercial refrigeration appliances transitioning to refrigerants that do not contain an HFC or substitute for an HFC with a GWP greater than 53. In response to the 2023 Technology Transitions Rule, EPA anticipates that many IPR and commercial refrigeration appliances will transition to alternatives with a GWP less than or equal to 53 and thus those refrigerant-containing appliances will not be subject to the ALD requirements described in this section. EPA has identified 16 manufacturers of ALD systems for market, in the United States. There are 13 manufacturers making direct ALD systems and four manufacturers making indirect ALD systems (one manufacturer was identified to make both types of ALD systems). The majority of installed systems are likely direct ALD systems. EPA estimates that one of the largest manufacturers of direct ALD in the United States makes between 6,500 and 7,000 direct ALD systems per year. For additional information and details on the estimated emissions reductions and costs related to ALD systems, see the TSD titled *Analysis of the Economic Impact and Benefits of the Proposed Rule* available in the docket for this action.

Comment: The Agency received several comments concerned with the supply of ALD systems. A few commenters stated there will be serious challenges to obtaining enough ALD systems within the proposal's compliance timeline. Commenters cited inadequate lead times to procure ALD systems and supply chain issues. One commenter claimed that they have been notified by manufacturers and suppliers for the need of extended lead times when ordering new equipment as all parts of the supply chain are facing challenges, such as manufacturing, delivery, and installation. Another commenter stated there are existing methods and technologies for leak detection in outdoor areas that would serve as suitable alternatives to an ALD system, considering the challenges of the proposal's timeline. One commenter claimed that the manufacturing capacity for both direct and indirect ALD systems would likely make industry unable to meet the demand during the one year allotted for existing systems under the proposal. They requested that EPA conduct a more thorough analysis of the capabilities and capacities of ALD system manufacturers to meet the one-year peak demand caused by the proposal. The commenter also requested EPA consider the feasibility and cost of its proposal based on that information before finalizing.

One commenter, an ALD manufacturer requested that EPA extend the compliance timeline for the installation of ALD to 2 years based on their understanding of the ALD market and manufacturer's ability to meet demand. The commenter stated that in point detection systems, each point can be considered as an individual system which is likely why EPA projects a need for 50,000 systems within the first year. However, the commenter claimed, in an aspirated low-level detection setup, a facility may have 16 zones with multiple sampling points in each zone all incorporated into one system. For this reason, the commenter expected market demand for low-level aspirated systems (which the commenter suggested will serve as primary direct detection technology used to meet AIM Act requirements) to be approximately 3,100 units annually. The commenter claims that they are the only ALD manufacturer with existing production volume levels demonstrating the capability of meeting demand of this magnitude.

Lastly, one commenter stated that indirect ALD systems, which they manufacture, can be deployed across thousands of sites more quickly and cost-effectively than solutions that require onsite hardware and site visits, in addition to providing industry more flexibility. The commenter also explained the largest bottleneck for the implementation of indirect ALD were corporate IT security processes, which can take weeks to months. Once the IT approvals are completed, the installation of indirect ALD is prompt. The commenter is confident that they, and other ALD manufacturers identified by EPA, have the ability to meet the large surge in ALD system deployments that would be required under the proposed rule.

Response: In the final rule, EPA has extended the compliance date of new applicable refrigerant-containing appliances to January 1, 2026, and has changed the applicability of existing IPR and commercial refrigeration appliances to those installed on or after January 1, 2027, and have extended the compliance date to 2027. For new refrigerant-containing appliances subject to this provision the Agency has provided an additional year to install an ALD system. Existing refrigerant-containing appliances subject to this provision have more than two years to install an ALD system. With these changes the Agency estimates that approximately 25,000 refrigerant-containing appliances will be required to install an ALD system between 2025 and 2027 which will greatly reduce the demand for such systems, limit potential supply chain issues, and further limit demand related costs increases. EPA has provided owners or operators with additional time to plan, procure, and install an ALD system which meets the requirements described in 40 CFR 84.108, even when considering lead times that may be associated with ordering ALD systems. Additionally, as reflected in comments from ALD manufacturers, the supply of ALD systems is able to meet the demand for ALD systems caused by this final rule's provision. The Agency has also provided additional time, as one of the manufacturer's requested, to ensure the ALD suppliers can manufacture and supply ALD systems to owners and operators subject to the ALD installation requirements. The additional time will also provide owners or operators time to work through corporate IT processes so they can quickly implement indirect ALD systems. For these reasons, the Agency disagrees with one commenter's perspective that ALD manufacturers would not be able to meet the demand for ALD systems. EPA with additional consideration, informed by comments find the supply of ALD systems to be adequate to meet the compliance dates established in this final rule.

The Agency disagrees with one commenter's claim that there are existing methods and technologies for detecting leaks in outdoor areas which are suitable alternatives to ALD. The commenter did not provide any additional information on what these methods or technologies would include, nor did they specify how such technologies would continuously monitor refrigerant-containing appliances. The Agency is aware that direct ALD systems cannot detect refrigerant outdoors, however, the final rule specifically requires the use of direct ALD systems to monitor leak-prone components within an enclosed space. Furthermore, leak inspections following a successful follow-up verification test are required for all portions of an appliance not monitored by a direct ALD system. Additionally, indirect ALD systems are capable of monitoring the entire refrigerant-containing appliance. For these reasons, EPA disagrees with the commenter's views that there are available techniques or technology that can supplant the need for ALD systems.

Direct refrigerant leak detection systems are fixed hardware that continuously monitor the concentration of refrigerants in the air. Continuous monitoring of a refrigerant-containing appliance can also include direct ALD systems which directly monitor said appliance through cycling. For direct ALD systems, it is essential that gas sensors are located at all leak-prone components of a refrigeration system; otherwise, some leaks may go undetected. The benefits of direct ALD systems include being able to pinpoint the location and severity of a leak. Direct ALD systems are commissioned to send an "alarm" to maintenance and/or operations staff if the programmed leak level threshold is exceeded. EPA is not establishing a definition of direct ALD systems in this rulemaking and clarifies that any direct ALD system which meets the criteria described in 40 CFR 84.108(f)(1)(2)(3) (*e.g.*, accurately detect a concentration of 10 ppm of vapor) is acceptable to use. Some types of acceptable direct ALD systems include but are not limited to:

- Point gas detection systems;
- Aspirated (or pumped) detection systems.

EPA is requiring owners or operators using direct ALD systems to comply with the provisions to detect and repair refrigerant leaks in appliances. Leak detection sensors must be capable of accurately detecting a concentration level of 10 ppm of the vapor of the specified refrigerant and must alert an owner/operator if refrigerant concentrations exceed 100 ppm. As discussed in the proposal, the technical feasibility of the 100 ppm threshold is well established. This has been the threshold used by the CARB and is also the standard in provisions at 40 CFR 82.157(g)(4)(i) for ALD systems that are used as a compliance option in lieu of quarterly or annual leak inspections, as part of the leak repair requirements under CAA section 608. If a leak is detected above the 100 ppm threshold, the owner or operator is required to either perform a leak rate calculation to determine if the leak rate threshold has been exceeded, or alternatively they may preemptively repair the leak before adding refrigerant and calculating the leak rate. In order to calculate the leak rate, EPA refers the reader to section IV.C.3.a of this action. EPA is requiring that a leak rate calculation must be performed within 30 days (or 120 days where an industrial process shutdown is necessary) of the alarm where a direct ALD system is used for required equipment. If the calculated leak rate is above the applicable leak rate, as discussed in section IV.C.3.a of this preamble, all of the leak repair requirements in this action (including the repair requirements, inspections, verification tests, and recordkeeping and reporting) will apply.

Alternatively, if the owner or operator chooses to preemptively repair the detected leak, a leak rate calculation must be performed after the preemptive repair; however, the leak rate calculation must still be performed within 30 days (or 120 days where an industrial process shutdown is necessary) of the alarm where a direct ALD system is used for applicable appliances, and accordingly the preemptive repair will also need to occur in that time frame. If the leak rate calculation (performed after the addition of refrigerant pursuant to the follow-up verification test) conducted after the preemptive repair reveals that the appliance had leaked above the applicable leak threshold, the suite of leak repair requirements would apply. The preemptive repair actions can be considered in determining whether the suite of leak repair requirements triggered by the exceedance of the applicable leak threshold have been satisfied, but the owner or operator of the appliance must still ensure that the leaks had been repaired according to the definition of repair and that the other requirements in 40 CFR 84.106 (*e.g.*, initial and follow-up verification tests, leak inspections (where applicable), and related recordkeeping) had been met. By allowing a leak detected by an ALD system to be preemptively repaired before the addition of refrigerant and calculation of the leak rate, EPA anticipates that this will avoid requiring owners and operators to add refrigerant to a system with a known leak, thereby saving the cost of refrigerant that might subsequently leak prior to the repair, as well as prevent unnecessary emissions of refrigerant. Additionally, preemptive repair of leaks allows owners or operators to have a "head start" on repairing leaks if it is later found that the applicable leak rate threshold has been exceeded when the leak rate calculation is performed.

Comment: EPA received several comments on direct ALD systems. One commenter expressed concern with the proposed language "for direct ALD systems, it is essential that gas sensors are located at all leak-prone components of a refrigeration system." The commenter views this framing as providing too much flexibility that could lead to unintended outcomes (*i.e.,* ineffective implementation of ALD that does not lower refrigerant leak rates as desired). The commenter claimed that in California, many facilities mount single-point (passive diffusion) gas detectors on the wall of the mechanical room to comply with CARB regulations. The commenter stated that this method is technically compliant with ALD requirements but is only partially effective at detecting leaks in the mechanical room (due to its distance from most refrigeration components in the mechanical room) and it is completely ineffective at detecting leaks in other parts of the facility outside of the mechanical room. The commenter recommended adding clarifying language to ensure that gas sensors are located within six feet of all leak-prone components of a refrigeration system. The commenter also recommended defining "leak-prone components of a refrigeration system" as "all components of a refrigeration system that contain liquid or gas except for straight runs of piping, inclusive of compressors, evaporators, valves, condensers, headers, receivers, oil separators, oil traps, accumulators, other pressure vessels, etc."

Another commenter provided information on the applications of different types of direct ALD systems in the HVACR industry. The commenter stated point detectors serve a primary purpose of enabling compliance with operational safety guidelines for personnel. The commenter asserted that the devices are typically wall-mounted within an occupied space and sometimes cannot detect a leak due to dilution and air exchange in the greater space which can cause the room to remain below the 500-900 ppm alarm level set for personnel safety. For these reasons, the commenter argued that these detection systems are used for occupant safety and not as a targeted solution for emissions reduction. The commenter also claimed that the proposed rule could be read to preclude aspirated detection systems (*e.g.,* requiring "continuous" monitoring and placement of the "sensor"). Therefore, the commenter proposed modifying the language to replace "continuously monitor" with "actively monitoring." Alternatively, the commenter proposed that "continuously monitor" could be defined to include devices that actively or directly monitor via cycling. The commenter stated that without one of these edits, the proposed rule would not allow for low-level leak detection equipment that is designed to identify leaks for environmental purposes and requires an established cycle time to sample multiple points, rather than "continuously monitor" one specific point. The commenter also suggested that EPA remove "condenser" from its examples of what components a direct ALD system should be monitoring.

Response: EPA acknowledges commenter's concerns with the implementation of direct ALD systems. EPA disagrees that the description of ALD in the preamble provides too much flexibility to owners or operators which will result in ineffective leak detection. The agency clarifies that direct ALD sensors must be placed on or near leak-prone components (*e.g.,* compressor, evaporator, condenser) or along points of the entire refrigerant circuit if it is entirely enclosed within a building or structure. EPA is not specifying a set distance for gas sensors as the commenter suggests but we strongly encourage the owners or operators install gas sensors as close to components as possible. EPA agrees that a single wall mounted point detection system in a mechanical room is ineffective at detecting leaks. The Agency reiterates direct ALD gas sensors will need to be placed on or near leak prone components so that an appliance is adequately monitored for leaks. EPA is not prescribing a set number of sensors because the refrigerant-containing appliances subject to these requirements are varied in design, however, the Agency clarifies that multiple gas sensors may be required to meet the standards for direct ALD systems. The Agency is not finalizing the commenter's proposed definition of "leak-prone components of a refrigeration system" because the Agency has already finalized a definition for component: "as it relates to a refrigerant-containing appliance, means a part of the refrigerant circuit within an appliance including, but not limited to, compressors, condensers, evaporators, receivers, and all of its connections and subassemblies." The leak-prone components where gas sensors are to be placed for direct ALD systems fall under that definition. The Agency agrees that direct ALD systems are not effective for portions of an appliance that are outside of an enclosed space however, for portions that are located within an enclosed space that have a high chance for leakage EPA finds it appropriate to use direct ALD systems. When a leak is detected and refrigerant-containing appliance found to be above the applicable leak rate an owner or operator is required to inspect all portions of a refrigerant-containing appliance not monitored by an ALD system as discussed in section IV.C.3.d.

In response to one commenter's request to modify the description of direct ALD in the rule EPA has provided additional detail on what types of direct ALD systems are acceptable to use. As discussed in the preamble, the Agency is not establishing a definition of direct ALD systems in this rule however, EPA clarifies that any direct ALD systems that meet the criteria described in 40 CFR 84.108(f)(1)(2)(3) are acceptable to use for the purposes of leak detection. This would include the use of point detection systems, aspirated detection systems, or any other existing or future direct ALD technologies that can accurately detect a concentration level of 10 ppm of vapor of the specific refrigerant(s) used in an appliance, alert the owner or operator of when a refrigerant concentration of 100 ppm is reached, and is able to have sensors or intakes which continuously monitor the refrigerant concentrations in air in proximity to leak-prone components. EPA is not changing the term "continuously monitoring" however we further clarify that the term does not preclude the use of direct ALD systems that actively or directly monitor an appliance via zonal cycling. EPA views direct ALD systems which actively monitor portions of a refrigerant-containing appliance as falling under the term "continuously monitor." EPA disagrees with the commenter's claims that point detection systems cannot adequately provide leak detection monitoring for the purposes of leak reduction. While it is true that point detection systems are utilized to comply with occupational safety standards, point detection systems that meet the standards of the final rule are also able to provide adequate leak detection and monitoring for a refrigerant-containing appliance. EPA reiterates that a single wall-mounted point detection sensor would not provide adequate coverage for an appliance thus, multiple sensors are needed to cover leak-prone components on an appliance. EPA is also not preventing the use of any direct ALD system which meets the rule's standards because the Agency does not want to further limit the supply of direct ALD systems for owners or operators. The Agency's standards for direct ALD serve the purpose of minimizing the release of refrigerants from appliances while also providing enough flexibility in direct ALD technologies so that owners or operators are able to comply with the rule's ALD provision within the provision's compliance timeframe.

Comment: The Agency received numerous comments on the alarm criteria thresholds for direct ALD systems. The majority of commenters requested EPA reconsider the proposed 100 ppm threshold and finalize at a lower threshold, either 50 ppm or 10 ppm. One commenter suggested using a <10 ppm threshold to achieve full emissions reduction potential. The commenter cited their report on refrigerant leaks at major supermarket stores demonstrating that many commercial refrigeration leaks are under 10 ppm. Of all the leaks the commenter detected across dozens of stores, less than 5 percent were at a concentration greater than 100 ppm, however, 29 percent ranged from 10-100 ppm on the sales floor. The remaining 67 percent of leaks were found to have concentrations less than 10 ppm. Thus, the commenter advocated EPA use an alarm threshold lower than 10 ppm because small concentrations of refrigerant can be indicative of large leaks within an appliance. Another commenter recommended the alarm threshold be lowered to 10 ppm because of improvements in sensor technology. Finally, one commenter stated the 100 ppm threshold may need to be lowered if EPA is seeking ALD from flanges in a central location. The commenter further suggested that EPA consult with CARB or others to verify the efficacy of the 100 ppm threshold.

One commenter recommended an alarm threshold of 50 ppm for direct ALD systems while maintaining an accurate detection down to 10 ppm of the vapor of the specified refrigerant because small leaks under 100 ppm can result in substantial or complete loss of a refrigeration system over time. The commenter stated that aspirated ALD systems can detect refrigerant vapor at a resolution of 1 ppm and capable of alerting an owner/operator at an alarm threshold of 10 or 25 ppm. However, the commenter suggested that a 50 ppm alarm threshold would be more appropriate because small leaks could be more readily detected and reduce nuisance alarms that may happen more frequently at lower alarm thresholds. The commenter clarified that nuisance alarms are not the result of noise rather they occur because the aspirated ALD systems can detect leaks that would have been otherwise unknown to an owner/operator prior to installation of the ALD system. The commenter also recommended EPA not grandfather any direct ALD systems with alarm levels above 50 ppm as existing direct ALD systems set to 100 ppm are solely meeting safety requirements and are not equipped to minimize release of refrigerant.

Another commenter claimed that long term ppm limits may not be the best approach to regulate ALD systems as ppm metrics are specific to the sensor and do not directly correlate to the ability to detect a leak rate over a given time. The commenter also stated that they are aware of only one sensor on the market that can detect to a 10 ppm resolution. The commenter provided several examples of existing direct ALD systems and provided suggested ppm levels of detection that are appropriate for the type of direct ALD system. For aspirated systems, the commenter suggested a threshold of 10 ppm as appropriate. For single-zone diffusion (point detection) systems the commenter suggested a threshold of 200 ppm would be more appropriate. Finally, for appliance-level sensors, primarily used to comply with UL 60335-2-89 for the use of flammable refrigerants, the commenter suggested a minimum threshold of 500 ppm.

Response: EPA is finalizing the alarm threshold for direct ALD systems as proposed. The Agency finds the alarm threshold as appropriate to detect leaks from refrigerant-containing appliances faster while preventing false alarms which may occur at lower ppm thresholds. EPA also finds it appropriate to remain consistent with existing alarm criteria under the CAA and state refrigerant management programs. EPA disagrees with one commenter requesting that the Agency not grandfather existing ALD systems with alarm thresholds above 50 ppm. While a portion of ALD systems currently in use were installed to meet safety standards many other ALD systems were installed by owners or operators for the purposes of leak detection. The Agency is not requiring owners or operators with existing ALD systems that meet the standards in 40 CFR 84.108(f)(1)(2)(3) to install new ALD systems. Owners or operators with existing ALD systems will need to ensure their current ALD systems meets the rule's standards and are providing adequate monitoring of leak-prone components of a refrigerant-containing appliance. Additionally, the Agency does not want to deny existing ALD systems which meet the standards of this rule because it may exacerbate potential ALD supply issues and reduce overall compliance with the provision.

EPA acknowledges the information one commenter provided on leaks detected at supermarkets and agree that small amounts of refrigerant detected can be indicative of larger leaks within a refrigerant-containing appliance. However, EPA does not find the 100 ppm threshold as being incongruous with the discovery of large leaks and the timely repair of refrigerant-containing appliances that are leaking above the applicable leak rate threshold. EPA reiterates that this rule is not requiring the repair of all leaks, rather, this rule is requiring that leaks are repaired to the extent that a refrigerant-containing appliance is leaking below the applicable leak rate threshold. In the context of the appliances subject to this provision the leak repair provisions would begin once the leak rate has exceeded 30 percent for IPR and 20 percent for commercial refrigeration appliances. Setting the threshold to <10 ppm, 25 ppm, 50 ppm or any other threshold below 100 would in fact alert an owner/operator to the presence of more leaks. However, these discovered leaks would most likely not cause the refrigerant-containing appliance to exceed its applicable leak rate threshold. For example, if EPA were to set the alarm threshold at 10 ppm a pinhole leak on a component near a sensor may alert an owner or operator for a relevantly small leak. The ALD provision of this final rule is intended to find larger leaks faster in refrigerant-containing appliances which can emit large amounts of refrigerant from one leak event. When a larger leak is detected by an ALD system the owner or operator has 30 days to conduct a leak rate calculation or attempt to preemptively repair the leak. Since EPA is not requiring the repair of all leaks setting the alarm criteria below 100 ppm could create a situation where an alarm is continually alerting an owner or operator of a leak that has been found to not be causing the refrigerant-containing appliance to be leaking above the applicable threshold. Nuisance or false alarms from ALD systems may decrease compliance with the leak repair provisions of the final rule because owners or operators may begin to ignore alerts for the ALD system. Thus, the 100 ppm alarm threshold reduces the risk of false alarms while ensuring that larger leaks from refrigerant-containing appliances are detected and alert owners or operators to take further action.

Regarding one comment asserting that ppm may not best approach to regulate ALD systems because ppm does not correlate to the ability to detect a leak rate, EPA clarifies that the purpose of the ALD provision is to detect leaks sooner not calculate the leak rate of a refrigerant-containing appliance. As previously discussed in section IV.C.3.a the final rule's leak rate calculation methodologies are the only appropriate way to calculate a refrigerant-containing appliance's leak rate. The comment is correct that ppm values of a refrigerant cannot denote how much refrigerant has leaked from a refrigerant-containing appliance however, it does alert an owner or operator to the presence and potential severity of a leak which must be addressed if the refrigerant-containing appliance is leaking above the applicable leak rate. EPA also disagrees with the commenter's suggestion to base ppm thresholds on the type of direct ALD system as this may add additional complexity and confusion to the ALD requirements and may diminish compliance with the provision. The Agency reiterates that direct ALD systems which meet the standards in 40 CFR 84.108(f)(1)(2)(3) are acceptable to use. If a direct ALD system cannot meet those standards, then it is not appropriate to use for this rule's ALD requirements.

Comment: The Agency also received comments in opposition of lowering the alarm thresholds for ALD systems. One commenter did not support lowering the alarm thresholds below what EPA proposed because lower thresholds could result in more frequent alarms, potentially leading to operational disruptions and false alarms. Another commenter claimed the proposed conditions of use for ALD systems are arbitrary and capricious because they will cause numerous false alarms. The commenter stated the proposed 100 ppm alarm rate for direct ALD systems and the 50 pound or 10 percent loss of charge for indirect ALD systems are based on ALD system manufacturer recommendations, and not an actual correlation with leak rates. The commenter asserted that it is unreasonable for EPA to adopt regulatory trigger rates, unless EPA has studied a correlation of the alarm levels with a statistical leak rate or probability of leaks. In the commenter's members' experience with ALD systems neither of the alarm thresholds are indicative of leaks. They recommend the Agency not mandate any alarm threshold below 100 ppm and to not require mandatory inspection unless alarms recur over a several-day period if the provision is finalized as proposed. One commenter stated the Agency should allow for flexibility requests for unforeseen circumstances. The commenter claimed that EPA would be inundated with nuisance reporting every time an ALD triggers. The commenter suggested that EPA should consider limiting alerts to above a CO_2eq limit, if they proceed with the requirement.

Response: The Agency is finalizing the 100 ppm alarm threshold as proposed. EPA disagrees with the comments asserting that the set alarm criteria is entirely based on manufacturer specifications, will lead to numerous false alarms, and is unreasonable or arbitrary and capricious. If EPA were to base the alarm criteria of this final rule solely on manufacturer's specification the final threshold would be much lower. For example, one ALD manufacturer submitted public comments on the proposed rule requesting that the Agency reduce the alarm threshold based on their sensor specifications being capable of detecting refrigerant vapor well below 100 ppm. EPA is finalizing the 100 ppm threshold based on several considerations. For instance, the Agency considered the use of 100 ppm as one of the criteria for a direct ALD system that is used in lieu of quarterly or annual leak inspections under EPA's regulations under section 608 of the CAA, at 40 CFR 82.157(g)(4)(i). The alarm criteria of 100 ppm for ALD systems is also consistent with some state's refrigerant management programs and consideration of information from ANSI/ASHRAE Standard 15-2001 Safety Standards for Refrigeration Systems, among other factors. Based on consideration of this information, as well as comments on the proposed rule, EPA concludes that this threshold is technically feasible and should be familiar to some stakeholders from their experience under other regulatory programs, thus facilitating implementation of these requirements. Further, if the alarm threshold is set too high, the system may miss some leaks that should be addressed and thus would fail to serve its intended purpose. EPA understands that a 100 ppm threshold will minimize the risk of false alarms. However, to the extent that commenters are concerned about false alarms, under the final rule, they may elect to perform a leak rate calculation in response to an alarm, and if that calculation indicates that the equipment is not leaking above the applicable leak rate threshold, no further action would be required.

The Agency also disagrees with the commenter's position that establishing a regulatory trigger rate for the ALD equipment would need to be based on a statistical evaluation of leak rates or the probability of leaks. The Agency clarifies that the ALD requirements serve the purpose of detecting leaks within a refrigerant-containing appliance earlier but are not intended to substitute for the calculation or evaluation of a refrigerant-containing appliance's leak rate. The alarm criteria for direct ALD systems are a specification for such systems to alert owners or operators to a potential leak and is not used to determine a refrigerant-containing appliance's leak rate or the actual severity of a leak, only the presence of a leak. EPA finds the 100 ppm alarm threshold as appropriate to serve the purpose of alerting the owner or operator of a leak which may potentially cause a refrigerant-containing appliance to leak above the applicable leak rate threshold. The Agency has provided information on the leak rate calculation methodologies and when leak rate calculations must be completed in section IV.C.3.a. As noted previously, requiring use of ALD systems is consistent with the authority under in subsection (h)(1) to promulgate regulations control, where appropriate, any practice, process, or activity regarding servicing, repair, or installation of such appliances, which involve a regulated substance or substitute for a regulated substance. When an ALD system provides an alarm in a refrigerant-containing appliance covered by this provision, the owner/operator must perform practices, processes, and/or activities to determine whether the equipment is leaking above the applicable leak-rate threshold and whether service or repair of the refrigerant-containing appliance is needed. The ALD requirements help to minimize releases of regulated substances from equipment and maximize the amounts of refrigerants remaining in equipment for eventual recovery and reclamation.

EPA disagrees with the commenter's experience that the final rule's alarm thresholds are not indicative of leaks and disagree that ALD system alarms should not be addressed until several days of a continuous alert. The final rule allots 30 days (120 in the event of an industrial process shutdown) to calculate the leak rate or attempt to preemptively repair a refrigerant-containing appliance. The leak repair provisions of this final rule apply once the owner or operator has determined the leak rate has exceed the applicable leak rate threshold. EPA clarifies that the 30-day timeframe for calculating the leak rate begins once the owner or operator has received an alarm from their ALD system. This should provide ample time for an owner or operator to address an alert from an ALD system. The Agency is not claiming that false alarms will never happen; however, as previously mentioned the alarm threshold for ALD systems has been set to mitigate the risk of false alarms and operational disruptions from occurring. If an owner or operator is continually having issues with false alarms from their ALD system they may consider performing additional calibration or audits to ensure the ALD system is functioning properly.

For similar reasons, EPA disagrees with a separate commenter asserting that more time or flexibility would be needed to address ALD system alerts due to unforeseen circumstances. The commenter incorrectly stated that the owners or operators would need to report alarms from ALD systems to the Agency. EPA clarifies that owners or operators are required to keep records of each date that an ALD alarm is triggered (see 40 CFR 84.108(i)) and are not required to report each ALD system alert to EPA. Additionally, the Agency disagrees with the commenter's suggested alarm criteria being based on the exceedance of a CO_2eq thresholds. As previously stated, EPA is finalizing the alarm criteria for ALD systems to help detect leaks early, so that if there are leaks that exceed the leak rate threshold, they can be addressed in a timely fashion. A CO_2eq threshold would not further this purpose. Further, EPA is unaware of any ALD system that can provide accurate alarms based on a CO_2eq threshold as direct systems are detecting the presence of refrigerant vapor in the air and indirect systems are detecting volumes of refrigerant lost via data metrics. The final rule sets an appropriate threshold for owners and operators to address detected leaks in a timely manner and reduce the emissions of refrigerant from refrigerant-containing appliances.

Comment: The Agency received a few comments regarding the preemptive repair provision in the final rule. One commenter stated that setting a requirement for direct ALD systems to alarm at 100 ppm but allowing no action to be taken if the leak rate thresholds are not exceeded, does not further the objective of minimizing release of refrigerant. The commenter also stated that the ALD system will continue to alert an owner or operator of the leak if left unrepaired. The commenter suggested de-coupling the requirement of a leak rate calculation before fixing a leak identified by an ALD system and asserted the rule may be confusing for industry and interpreted as undermining the need for ALD. The commenter further claimed that the best route for leak mitigation is to find and fix all leaks over the applicable threshold and that preemptive repair should be the only recommended solution for leak resolution because the addition of refrigerant to a leaking appliance will result in the loss of the added refrigerant. The commenter asserted that the leak rate calculation can occur after the repair of the leaking appliance.

Another commenter requested clarification on whether an owner or operator needs to calculate a leak rate after preemptive repair is conducted. The commenter stated that the rule appears to offer two compliance options when an ALD system detects a leak, calculate a leak rate and assess whether the appliance is leaking above the applicable leak rate threshold or preemptively repair the leak. The commenter asserted that the requirement of a leak rate calculation seems to be in conflict with EPA's rationale for preemptive repair discussed in the preamble: "to avoid the need to add refrigerant to an appliance with a known leak (which would otherwise generally be necessary to calculate the leak rate and determine if the applicable leak rate is exceeded)." The commenter further claimed that the requirement to conduct a leak rate calculation will cause owners or operators to incur additional costs to add refrigerant to a fully functional system for the sole purpose of a leak rate calculation. As currently written, the commenter stated that the provision may be economically burdensome and could add on to system downtime. Thus, the commenter suggested the Agency clarify in the regulatory text to not require a leak rate calculation if an appliance is preemptively repaired.

Response: EPA acknowledges one commenter's recommendation that the leak rate calculation be decoupled from the final rule's preemptive repair provision for leaks detected by an ALD system and clarifies that these are separate requirements. EPA does not view the leak rate calculation and ALD requirements as incongruous, rather where both apply, they are separate parts of an overall approach to addressing leaks from refrigerant-containing appliances, nor does the Agency find that having both requirements will cause confusion as the commenter suggested. The required use of ALD systems for IPR and commercial refrigeration above 1,500 pounds and the option to preemptively repair a refrigerant-containing appliance rule is not intended to replace the need to calculate the leak rate and to repair leaks so a refrigerant-containing appliance is below the applicable leak rate threshold. As noted previously, EPA is not requiring the repair of all leaks, however, the Agency encourages owners or operators to preemptively repair leaks detected by an ALD system. The determination of a leak rate for a leaking refrigerant-containing appliance is vital to ascertain if a refrigerant-containing appliance must be repaired. EPA is providing some flexibility to owners or operators who have been alerted of a leak to either preemptively repair the refrigerant-containing appliance or calculate the leak rate of said appliance to determine if the owner or operator must proceed with the leak repair process. The commenter asserted that preemptive repair should be the only recommend solution for leak resolution however, if a refrigerant-containing appliance is found to have been leaking above the applicable leak rate threshold after the completion of a preemptive repair the refrigerant-containing appliance would still be required to follow through with the rest of the leak repair process (*e.g.,* verification tests, leak inspections, etc.). Furthermore, the Agency reiterates that the final rule is not requiring the repair of all leaks, rather, this final rule requires that leaks be repaired to the extent that they bring the refrigerant-containing appliance below the applicable leak rate threshold. There may be some scenarios were an owner or operator may decide to calculate the leak rate as soon as possible to determine the severity of a leak and determine if further action is needed. Additionally, records of leak alerts from an ALD system which do not push the refrigerant-containing appliance above the leak rate threshold at the time of the alarm will inform an owner operator if their refrigerant-containing appliance is having issues with smaller leaks (*e.g.,* pinhole leaks).

Regarding one commenter's questions on the requirement of a leak rate calculation after the preemptive repair of a refrigerant-containing appliance, the Agency notes that the option to preemptively repair a refrigerant-containing appliance does not remove the necessity to conduct a leak rate calculation. As previously discussed, the option to preemptively repair a refrigerant-containing appliance and the calculation of a refrigerant-containing appliance's leak rate are separate parts of an overall approach to addressing leaks from refrigerant-containing appliances. The commenter is correct that the Agency is providing two compliance pathways when a leak is detected by an ALD system, however, EPA clarifies that its rationale for the preemptive repair provision is intended to reduce the emissions of refrigerant from an appliance that is known to be leaking. EPA encourages owners and operators to preemptively repair a refrigerant-containing appliance for this reason but is not requiring an owner or operator to do so. In both compliance scenarios the owner or operator will need to conduct a leak rate calculation to determine if the refrigerant-containing appliance was leaking above the applicable leak rate which requires the owner or operator to conduct the rest of the leak repair process, even if the leak(s) were preemptively repaired. Preemptive repair gives owners or operators a "head start" to the leak repair process and is not a replacement for the leak rate calculation of the refrigerant-containing appliance. The Agency disagrees with the framing of the commenter's claims on additional economic or operational burden to owners and operators associated with the calculation of the leak rate after preemptive repair. A refrigerant-containing appliance may be considered "fully functional" after preemptive repair, but a leak rate calculation is still required in order to determine if the appliance at the time of the ALD system alarm was leaking above the applicable threshold. If the refrigerant-containing appliance was leaking above the threshold it is required that the preemptive repair is verified and inspected per the leak repair provisions of this final rule to ensure the repair holds. EPA reiterates that the preemptive repair of an appliance is not a substitute for the calculation of a leak rate. Additionally, similar costs would be incurred if the owner or operator decided to not preemptively repair a refrigerant-containing appliance and just calculate the leak rate of said appliance which is then found to be leaking above the applicable leak rate. Thus, the Agency disagrees with the commenter's suggestion to remove the leak rate calculation if a refrigerant-containing appliance is preemptively repaired.

EPA is requiring owners or operators using an indirect ALD system to comply with the provisions to detect and repair leaks in appliances. The indirect ALD system must be calibrated to provide an alarm when the system has provided measurements that indicate that 50 pounds of refrigerant or 10 percent of the full charge of refrigerant, whichever is less, has leaked. EPA acknowledges that commercial refrigeration and IPR appliances would exceed the alarm threshold if 50 pounds of refrigerant had leaked from an appliance. Therefore, owners and operators subject to the ALD installation requirements in this final rule that are using indirect ALD systems would be alerted when a leak surpassed 50 pounds of refrigerant. For owners and operators not subject to the ALD installation requirements that are utilizing an indirect ALD system EPA understands that those owners and operators would receive an alert at 10-percent of full charge lost depending on the charge size of their refrigerant-containing appliance. For example, an appliance with a charge size of 200 pounds would alarm when 20 pounds of refrigerant is lost because the appliance has leaked 10% of its full charge. Once that alarm threshold has been surpassed, EPA is requiring the owner or operator to perform a leak rate calculation, or alternatively they may preemptively repair the leak before adding refrigerant and calculating the leak rate. The same requirements, as described elsewhere in this section, where an owner or operator chooses to do preemptive leak repair when using direct ALD system apply in the scenario where preemptive leak repair is performed when using an indirect ALD system. Similarly, EPA is requiring that a leak rate calculation be performed within 30 days (or 120 days where an industrial process shutdown is necessary) of the alarm where an indirect ALD system is used for refrigerant-containing appliances subject to this provision. If the calculated leak rate is above the applicable leak trigger rate (as discussed in section IV.C.3.a of this preamble), all of the leak repair requirements in this action (including the repair requirements, inspections, verification tests and recordkeeping and reporting) would then apply.

As described in the proposal, indirect ALD systems rely on data analytics to detect leaks rather than the direct detection of refrigerant gas. Indirect ALD systems monitor the operation of a refrigerant-based system to infer whether a leak is present. This method is typically conducted using existing sensors and hardware that are already located on site, and it relies on algorithms to evaluate existing conditions, such as liquid levels, temperatures, and ambient conditions to indicate if a leak is occurring. EPA understands that indirect systems can be calibrated to provide an alarm when a specified predicted refrigerant leak rate has occurred. The Agency is not establishing a definition of indirect ALD systems in this rulemaking and clarifies that any indirect ALD system which meets the criteria described in 40 CFR 84.108(g) is acceptable to use. Additionally, EPA is requiring that indirect ALD systems monitor at least two "measurements" to determine if a refrigerant-containing appliance is leaking above the final rule's alarm criteria. Some examples of appropriate measurements include but are not limited to temperature, liquid levels, pressure, and flow rate. Multiple measurements are required to ensure that an indirect ALD system is operating as intended and providing owners or operators with accurate data on the condition of their refrigerant-containing appliance.

The Agency clarifies that a 10 percent loss in full charge does not directly correspond to the leak rate threshold of 20 percent for commercial refrigeration and 30 percent for IPR. The 10 percent of total charge lost when an indirect ALD system alarms may equate less than or greater than an annualized leak rate of 20 or 30 percent depending on the timeframe over which the leak occurred. See section IV.C.3.a for more information on calculating the annualized leak rate. In any event, this difference is reasonable because the primary purpose of the ALD system is to allow the owner or operator to obtain knowledge of the leak earlier (*e.g.*, before operations are impacted) and to facilitate earlier repair, whether through preemptive repair before the leak rate threshold is exceeded or through required repairs after the leak rate threshold is exceeded. The technical feasibility of the "50 pounds of refrigerant or 10 percent of the full charge, whichever is less" standard is well established. This has been the threshold used by both CARB and is also the standard in provisions at 40 CFR 82.157(g)(4)(ii) for ALD systems that are used in lieu of quarterly or annual leak inspections, as part of the leak repair requirements under CAA section 608.

Comment: The Agency received mixed comments on the inclusion of indirect ALD in the proposal. One commenter supported the inclusion of indirect ALD systems in the proposed rule. Another commenter asserted that EPA should not allow indirect ALD systems as an alternative to direct ALD systems because indirect ALD systems are newer technologies that are unproven to satisfy the objectives of this rule. The commenter suggested that the final rule could include indirect detection as a helpful supplement to direct detection systems but should not replace or be permitted as an alternative to direct ALD. The commenter also stated that no indirect detection system currently complies with safety standards for occupied spaces and that an additional layer of direct ALD is required to comply with ASHRAE and other guidance that governs personnel safety. If indirect ALD systems are going to be considered as an alternative or substitute of direct detection, the commenter asserted that more prescriptive requirements need to be determined to equate the action levels with direct ALD systems and that EPA must provide clearer description of indirect systems.

Similarly, another commenter recommended that EPA require indirect ALD systems use multiple data points to determine if a leak is present. The commenter stated that many ALD systems registered under their refrigerant management program are indirect ALD systems that only use room temperature to determine whether a leak is present or not; however, newer indirect ALD systems generally use multiple data points working in tandem, such as temperature, pressure, liquid levels, etc., to help identify potential leaks. The commenter further stated that indirect ALD systems utilizing only a single data point (*e.g.*, temperature) are reactive to conditions that have occurred after a potential leak as opposed to indicating a leak when it first occurs, thus indirect ALD systems using multiple data points are more accurate at identifying and repair leaks.

Response: EPA acknowledges comments in support of the final rule's indirect ALD requirements. As described in the 40 CFR 84.108(g) indirect ALD systems must alarm when "measurements" indicate a loss of 50 pounds of refrigerant or 10 percent of full charge, whichever is less. EPA clarifies that it intends indirect ALD systems to be using multiple parameters in order to make determinations of refrigerant loss. EPA agrees that a single parameter being measured by an indirect ALD system may not be sufficient in accurately detecting leaks and may be subject to external forces that may result in a false alarm or no alarm at all. Thus, the Agency is clarifying that at least two measurements be used by an indirect ALD system to determine if an appliance has leaked above the alarm threshold. Some measurements include but are not limited to temperature, pressure, and flow rate. This clarification of indirect ALD systems using multiple parameters to accurately determine the presence and severity of a leak above alarm threshold should ease commenters' concerns on the viability of indirect ALD systems.

EPA disagrees with one commenter's assertion that indirect ALD systems are not an alternative to direct ALD systems. The Agency agrees that indirect ALD can be used in tandem with direct ALD for additional benefits. However, EPA finds any indirect ALD system that meets the standards outlined in 40 CFR 84.108(g) are acceptable to use because the indirect ALD systems are capable of alerting owners or operators of leaks just as direct systems can. The Agency disagrees with the framing of the commenters statement that indirect ALD systems are not able to comply with ASHRAE personnel safety standards. In the context of this final rule, the ALD requirements are designed to alert owners or operators of a leak earlier so that repairs of leaks above the applicable threshold can be made faster and thus, minimize the release of refrigerants form refrigerant-containing appliances. This rulemaking did not propose and is not finalizing that ALD be used to ensure technician safety. As previously discussed in the preamble of this section, EPA is aware of ASHRAE safety standards for A2L refrigerants and UL Standard 60225 2-40 requirements for the use of leak detectors for certain appliances.

Additionally, EPA finds that there are strengths and weaknesses of both leak detection technologies. For example, direct ALD can accurately detect the location of leaks if positioned well on or near an appliance, however, direct ALD cannot function well outdoors where ambient conditions can diminish the presence of refrigerant. Indirect ALD can monitor an entire appliance, including portions of an appliance that may be located behind walls or outdoors, and use metrics to determine if a leak has occurred. As the commenter stated, one issue with indirect ALD is its inability to definitively detect the precise location of a leak. EPA is not prescribing which ALD system owners or operators must use, instead we are requiring the use of an ALD system which meets the standards of this rulemaking and detect leaks early to minimize the release of refrigerants from equipment. Further, EPA understands that one type of ALD may suite the needs of an owner or operator better than the other. Allowing flexible options for ALD will facilitate compliance with this provision and ensure there is an adequate supply of ALD systems for owners or operators. If EPA were to limit the use of ALD to one system over the other, owners or operators may have difficultly installing ALD systems within the timeframe required by the final rule.

Comment: The Agency received a few comments concerning the alarm threshold for indirect ALD systems. One commenter stated that indirect ALD systems have the capability of detecting a leak with as little as one percent of full charge lost when data is reliable and available. However, to minimize the risk of false alarms at lower percentages (*e.g.*, ≤ five percent) the commenter recommends EPA finalize the proposed alarm criteria for indirect ALD systems. The commenter stated that the proposed alarm criteria would allow their manufactured systems to send leak alarm notifications with high confidence and reduce the risk of false positives which degrade customer confidence in leak alarm notifications.

Alternatively, one commenter stated that they were unaware of any standard or industry accepted procedure to verify the indirect ALD system is operating in a manner to detect 50 pounds or 10 percent of full charge. The commenter asserted that it was unclear how this requirement would be consistently applied and enforced, and that the Agency should better define the process of verification. Another commenter asserted that the alarm criteria for indirect systems are not equivalent to the alarm criteria for direct systems. The commenter claimed that indirect systems are not equipped to quantify the severity of the leak or pinpoint its precise location because indirect systems rely on data analytics and have not been developed for the purpose of retaining refrigerant in an appliance.

Response: EPA is finalizing the alarm criteria for indirect ALD systems as proposed. EPA acknowledges comments in support of the provision. EPA disagrees that there are no standards or industry accepted procedures to ensure indirect ALD systems are properly verified and calibrated to perform the function of leak detection. The alarm criteria for indirect ALD systems have been utilized by CARB since 2011. The alarm criteria under CARB's refrigerant management program for both direct and indirect ALD systems were based on ANSI/ASHARAE Standard 15-2001 Safety Standards for Refrigeration Systems. This alarm criteria were adopted by EPA in the 2016 Section 608 Rule for owners or operators who sought to implement ALD as a compliance option in lieu of quarterly or annual leak inspections. For these reasons, EPA finds it appropriate to adopt the same alarm criteria in this final rule. Additionally, the Agency clarifies that an owner or operator would need to follow the manufacturers specifications for an indirect ALD system to ensure it is properly calibrated to the appliance and that it is monitoring and performing the function of alerting an owner or operator when a leak is detected above the lesser of 50 pounds or 10 percent of full charge. The final rule requires that indirect ALD systems are audited and calibrated annually and requires records to be kept detailing these annual audits and calibrations. Regarding the commenter's question to how this provision would be enforced, EPA notes that the recordkeeping for ALD systems in 40 CFR 84.108(i) would be used to determine if an owner or operator has been non-compliant and whether further enforcement action is necessary.

EPA also disagrees that the alarm criteria indirect and direct ALD systems are not equivalent because indirect and direct ALD systems are using different parameters to determine the existence of a leak and thus, the alarm criteria for both technologies will never be one-to-one. EPA clarifies that direct ALD cannot determine the severity of a leak based on ppm detection alone either, as the detection of ppm vapor of a refrigerant is not exactly correlative of how much refrigerant has leaked from an appliance. The only way to confirm the severity of a leak is via a leak rate calculation which is required within 30 days of an alarm for both direct and indirect systems. As discussed previously, direct and indirect ALD systems have strengths and weaknesses, however, indirect ALD systems not being able to determine the exact location of a leak does not preclude the technology from serving the purpose of alerting an owner or operator of a leak. Additionally, in the context of the appliances that are subject to the ALD requirements in the final rule (*i.e.*, IPR and commercial appliances with a charge size of 1,500 pounds or more) 50 pounds of refrigerant loss is a relatively small proportion of the appliance's full charge.

Direct ALD systems which alarm at 100 ppm of detected refrigerant concentrations may have leaked a comparable amount of refrigerant before alerting an owner or operator.

2. Recordkeeping and reporting

EPA is finalizing, as proposed, specific reporting and recordkeeping requirements for ALD systems in this action. Where ALD systems are required, EPA is requiring that owners or operators maintain records regarding the annual calibration or audit of the system. EPA is also requiring that records be maintained each time an ALD system triggers an alert, whether that be based on the applicable ppm threshold for a direct ALD system or the indicated loss of refrigerant measured in an indirect ALD system. When an ALD system alerts of a leak, EPA is requiring that the owner or operator maintain a record of the date the ALD system alerted to a leak and the location of the leak. EPA is also establishing recordkeeping requirements in the case where an owner or operator chooses to use an ALD system, where not required, as a compliance option in lieu of periodic inspections for an appliance that has exceeded an applicable leak rate. The recordkeeping requirements related to when a leak rate calculation must be conducted are described in section IV.C.3.g of this action. As discussed in section II.B, EPA's authority to require recordkeeping and reporting under the AIM Act is also supported by section 114 of the CAA, which applies to the AIM Act and rules promulgated under it as provided in subsection (k)(1)(C) of the AIM Act.

EPA is requiring that these records related to ALD systems, where required, be maintained for three years. Where ALD systems are being voluntarily used (*i.e.*, appliances with a full charge below 1,500 pounds or using a substitute for HFCs with a GWP of 53 or below), no recordkeeping is required. However, if an appliance using an ALD system is found to be leaking above the applicable leak rate and the owner or operator chooses to use the ALD system in lieu of periodic inspections, they are required to follow all requirements associated with this compliance option, including annual audits or calibration and all necessary recordkeeping requirements. The recordkeeping requirements in this action do not change any recordkeeping requirements where an owner or operator chooses to use an ALD system per 40 CFR 82.157(g)(4) for appliances containing ODS refrigerants.

Comment: EPA received a few comments on the reporting and recordkeeping requirements for its ALD provisions. One commenter supported the reduced recordkeeping requirements for facilities which opt into ALD in lieu of quarterly or annual inspects. The same commenter was supportive of recordkeeping requirements that demonstrate facility owners are performing the necessary calibration and maintenance of ALD systems however the commenter stated that the prescriptive installation and calibration may work against manufacturer specifications which should be followed to achieve optimal results. Another commenter supported EPA's proposed approach of not requiring ALD system alerts to be reported to the Agency and would oppose including any such reporting requirement in the final rule. If the Agency has the need to review these records, the commenter said they can always be requested from a facility rather than imposing an additional administrative burden on owners or operators and on EPA by requiring a report of every ALD alert. Lastly, one commenter reinforced the need for digital recordkeeping and recommended that digital records directly tied to the detection system be encouraged where possible.

Response: EPA is finalizing recordkeeping requirements for ALD systems as proposed. EPA acknowledges one commenter's request that ALD alerts not be reported to the Agency. Records of ALD alerts are required but EPA did not propose and is not finalizing that ALD alarms be reported to the Agency. The Agency agrees with one commenter's emphasis on digital recordkeeping and agree, that where appropriate, digital recordkeeping is appropriate for filing the information required under this provision. EPA clarifies that recordkeeping in a paper format is still acceptable as long as records are kept in the manner defined in 40 CFR 84.108(i). The Agency disagrees with one commenter's claim that annual calibration of ALD systems may go against manufacturers specifications. EPA is unaware of any manufacturer specifications that would make annual calibration and verification that an ALD system if functioning properly impossible or non-optimal. While owners or operators should rely on manufacturer specifications as it relates to the installation and operation of equipment, the Agency does not view the annual calibration and audits of ALD systems as out of sync with manufacturer specifications. ALD installations should largely align with manufacturer specifications, but owners or operators must ensure that all leak-prone components are monitored by an ALD system.

E. How is EPA establishing requirements for the use of recovered and reclaimed HFCs?

EPA is finalizing requirements for the use of recovered and reclaimed HFCs with modifications after consideration of the comments and information received on the proposed rule. EPA is requiring reclaimed refrigerants that contain HFCs to contain no more than 15 percent, by weight, virgin HFCs. The reclamation standard will apply as of January 1, 2026, and the provision includes certain recordkeeping, labeling, and certification requirements. EPA is also finalizing requirements for the use of reclaimed HFCs in the servicing and/or repair of refrigerant-containing equipment in supermarket systems, refrigerated transport, and automatic commercial ice makers. EPA also proposed to require the use of reclaimed HFCs in the stand-alone refrigeration subsector, but is not finalizing that requirement in this action. EPA is delaying the compliance date for these requirements by one year from January 1, 2028, to January 1, 2029. EPA is also establishing a discrete reporting requirement, as described in section IV.E.2.

Lastly, EPA is not finalizing requirements for the use of reclaimed HFCs in the initial fill of refrigerant-containing equipment at this time.

As described in the proposed rule, EPA interprets subsection (h) as including authority for EPA to establish regulations to control such practices, processes, or activities that are intended to increase reclamation of HFCs, as well as substitutes for HFCs, that are used as refrigerants. Such regulations could include those that are designed to increase market demand for reclaimed HFCs with a goal of increasing the amount of HFCs that are reclaimed, which would further serve the purpose of maximizing the reclamation of regulated substances. Consistent with this interpretation, EPA is establishing requirements for what constitutes reclaimed HFCs and the use of reclaimed HFCs in the servicing and/or repair of certain refrigerant-containing equipment. In this rulemaking, EPA is not establishing requirements for the use of reclaimed HFC substitutes; however, the Agency interprets the authority under subsection (h) to include establishing such regulations. Consistent with the proposal, EPA determined it would be prudent to focus the requirements finalized in this action on HFCs, given the HFC consumption and production phasedown will create scarcity for virgin HFCs and such demand can partly be addressed by increased use of reclaimed HFCs where possible.

EPA published a Notice of Data Availability (NODA) on October 17, 2022 (87 FR 62843), to alert stakeholders of information regarding the U.S. HFC reclamation market, available through a draft report, *Analysis of the U.S. Hydrofluorocarbon Reclamation Market: Stakeholders, Drivers, and Practices*.[79] EPA solicited stakeholder feedback and held a public

[79] Draft Report – Analysis of the U.S. Hydrofluorocarbon Reclamation Market: Stakeholders, Drivers, and Practices, October 2022. Available at: *https://www.epa.gov/system/files/documents/2022-10/Draft_HFC-Reclamation-Report_10-13-22%20sxf%20v3.pdf*.

stakeholder meeting shortly after the NODA was published on November 9, 2022.[80] EPA received comments[81] from various entities in response to the published NODA and from the stakeholder meeting, including comments from reclaimers, industry organizations, environmental non-government organizations (ENGOs), OEMs, and a private citizen. EPA held an additional public stakeholder meeting on March 16, 2023, and a webinar through EPA's GreenChill Partnership Program on April 12, 2023, and heard many similar comments to those received to the NODA.[82,83] Interested parties may view the draft report, the materials for the public meetings, and the comments the Agency received in response to the NODA in the docket for this action. An updated version of the draft report, titled *Updated Draft Report – Analysis of the U.S. Hydrofluorocarbon Reclamation Market: Stakeholders, Drivers, and Practices*, is available the docket of this action.

EPA is providing a final version of the report, titled *Analysis of the U.S. Hydrofluorocarbon Reclamation Market: Stakeholders, Drivers, and Practices*, that is also available in the docket of this action. EPA has incorporated information provided from commenters to this rulemaking (as further discussed and responded to in sections IV.E.1 and IV.E.2), including oral comments provided at the public hearing on November 2, 2023.

[80] Stakeholder meeting for input on an upcoming regulatory action under subsection (h) of the AIM Act, November 2022. Available at: *https://www.epa.gov/system/files/documents/2022-11/AIM%20Act%20Stakeholder%20Meeting_HFC%20Management_11-9-2022.pdf*.
[81] Comments submitted to response of NODA published on October 17, 2022 (87 FR 62843) are available in the docket for this rulemaking at *https://www.regulations.gov*.
[82] Stakeholder meeting on HFC reclamation under the AIM Act, March 2023. Available at: *https://www.epa.gov/system/files/documents/2023-04/HFC%20Management_Reclaimer%20Stakeholder%20Mtg_Final%203-15-23.pdf*.
[83] Webinar - Subsection (h) Under the American Innovation and Manufacturing Act, April 2023. Available at: *https://www.epa.gov/greenchill/webinar-subsection-h-under-american-innovation-and-manufacturing-act*.

1. Reclamation standard

EPA is finalizing, as proposed, that HFC refrigerant sold as reclaimed can contain no more than 15 percent virgin HFC refrigerant, by weight. This applies only to the HFC portion of reclaimed refrigerants, in the case of refrigerant blends with HFCs and a non-HFC component (*e.g.*, an HFC/HFO blend). EPA is also prohibiting, as proposed, the sale, distribution, or transfer to a new owner, or the offer for sale, distribution, or transfer to a new owner, of any regulated substance used as a refrigerant in stationary refrigerant-containing equipment (*i.e.*, not an MVAC or an MVAC-like appliance)[84] consisting in whole or in part of recovered regulated substances. This prohibition does not apply where the recovered regulated substances are reclaimed by an EPA-certified reclaimer (as described in 40 CFR 82.164) and have been reclaimed to the required purity standard, or if the recovered regulated substance is being sold, distributed, or transferred to a new owner, or offered for sale, distribution, or transfer to a new owner solely for the purposes of being reclaimed or destroyed. Further, EPA is clarifying that recovered refrigerant that is used by the same owner is regulated under 40 CFR 82.154(d). This rulemaking does not alter these requirements and does not prevent an equipment owner or operator from using refrigerant recovered from a piece of equipment they own to be used in that same piece of equipment or another piece of equipment they own.

EPA is also establishing labeling and recordkeeping requirements, as proposed, and prohibiting the sale, identification, or reporting of refrigerant as being reclaimed if the HFC component of the resulting refrigerant contains more than 15 percent, by weight, of virgin HFC. EPA proposed and is requiring that certified reclaimers affix this label to reclaimed HFCs being

[84] EPA further discusses MVAC servicing and recovered and reprocessed HFC refrigerants in section IV.I.

sold or distributed or offered for sale or distribution beginning January 1, 2026. The label is required to include the specifications as described in the regulatory text at 40 CFR 84.112(d). Additionally, EPA proposed and is requiring that certified reclaimers create and maintain a record related to the reclaimed HFCs filled in containers. EPA is requiring such records be generated beginning January 1, 2026, be maintained by reclaimers for three years, and include the following information:

- the name, address, contact person, email address, and phone number of the certified reclaimer,
- the date the container was filled with reclaimed HFC(s),
- the amount and name of the HFC(s) in the container,
- certification that the contents of the container are from a batch where the amount of virgin HFCs does not exceed 15 percent, by weight, of the total HFCs,
- the unique serial number of the container(s) filled from the batch,
- identification of the batch of reclaimed HFCs used to fill the container(s), and
- the percent, by weight, of virgin HFC(s) in the batch used to fill the container(s).

Consistent with the proposal, EPA is not requiring that each individual container or cylinder be rationed out to meet the allowable limit of 15 percent, by weight, of virgin HFCs. Rather, EPA is requiring at the batch level, that the reclaimed HFCs not exceed 15 percent, by weight, of virgin HFCs. As discussed in section IV.A.2, EPA proposed a definition of "virgin regulated substances" that would have included the heels removed from containers. However, EPA is finalizing a modification of that definition to mean "any regulated substance that has not had any bona fide use in equipment" but omitting the portion of the proposed definition that would have included heels. As a part of implementing this provision, EPA is also establishing that HFCs that are removed from the heels of containers do not contribute towards the limit of 15 percent, by weight, of virgin HFCs. EPA recognizes the value in the removed heels and, while the heels may be regulated substances that have not had bona fide use in refrigerant-containing equipment, EPA understands from comments on the proposed rule that some reclaimers may still reprocess removed heels to ensure the material will meet the applicable purity standards. EPA understands that, in the distribution chain, heels may be recovered into a common recovery cylinder along with refrigerant that had been recovered after a bona fide use in equipment.

EPA is finalizing these requirements to implement the statutory requirement in subsection (h)(2)(B) of the AIM Act which provides that any regulated substance used as a refrigerant that is recovered shall be reclaimed before being sold or transferred to a new owner, except where the recovered regulated substance is sold or transferred to a new owner solely for the purposes of being reclaimed or destroyed. This would be particularly relevant to the refrigerant-containing appliances for which EPA is establishing requirements to use reclaimed HFCs in the servicing and/or repair as described in section IV.E.2. These provisions are also intended to support the implementation of the statutory provision for stationary refrigerant-containing equipment in the context of other requirements established in this rulemaking, including by outlining more specific requirements for the reclamation that would need to occur before sale or any of the other listed activities for such regulated substances, as well as incorporating the statutory exception for situations where such recovered regulated substances are sold or transferred solely for the purposes of being reclaimed or destroyed. EPA further discusses its approach for recovered regulated substances used as refrigerants in MVAC equipment in section IV.I.

EPA is finalizing a standard for the amount of virgin HFC refrigerant that can be included in any reclaimed refrigerant containing HFCs to support consistent implementation of the requirements for the use of reclaimed HFCs in the installation, servicing, or repair of certain equipment in addition to establishing consistency on the amount of virgin HFCs in reclaimed HFCs. These requirements are being established as part of implementing subsection (h)(1) of the AIM Act, as these provisions would control practices, processes, or activities regarding the installation, servicing, or repair of equipment and would involve a regulated substance or the reclaiming of a regulated substance used as a refrigerant. As the HFC phasedown progresses, the overall quantity of virgin HFCs available, including to facilitate reclamation through blending or rebalancing, will decrease. In addition, the Agency considers that limiting the extent to which the purity standard for reclamation is achieved through combining with virgin refrigerant (besides what the Agency understands to be the necessary rebalancing, particularly of certain blends) in this rulemaking supports the purpose of maximizing reclamation, and additionally bolsters the available supply of reclaimed HFCs in the market.

Comment: Several commenters supported the 15 percent limit, by weight, on virgin refrigerant in reclaimed material. One commenter deferred to EPA regarding the amount of virgin material necessary to meet purity standards. Another commenter stated that it would be counterproductive to allow the use of more than 15 percent of virgin material given the proposed rule's rationale to boost the U.S. reclamation industry. Another commenter stated that the 15 percent threshold allows sufficient flexibility to reclaim refrigerants and further stated that higher virgin to reclaimed content ratios could constitute "greenwashing" thereby deceiving consumers on the environmental benefit of using a reclaimed refrigerant. One commenter, although generally supportive of the 15 percent virgin content limit, questioned whether the 15 percent limit applied to single-component refrigerants where blending is not necessary. Likewise, another commenter expressed support for the proposed limit of no more than 15 percent newly produced HFCs in multi-component refrigerant blends to qualify as a reclaimed blend, but also recommended that EPA require single component refrigerants to use 100 percent reclaimed material. One commenter supported the proposed 15 percent virgin HFC limit, and claimed it was reasonable and "ensures the continued existence of smaller reclaimers who must sometimes bulk up reclaimed gases to meet AHRI 700 purity standards." The commenter further recommended ramping down the acceptable proportion of virgin gas over time to incentivize better reclamation technology.

Several commenters supported a lower limit on the virgin content in reclaimed refrigerant. One of the commenters suggested the use of a virgin content limit for reclaimed material but encouraged EPA to tighten the requirement to send a clear message to the industry to invest in advanced reclamation technologies. The commenter noted that the 15 percent limit used by CARB was based on a term-limited program for a single state, while EPA's proposed use requirements for reclaimed HFCs will apply nationally and are not term limited; thus the requirements would send clear signals for investment in advanced reclamation technology. Another commenter similarly supported a maximum HFC virgin content in reclaimed HFCs, noting the importance of preventing large quantities of virgin HFCs from being blended with smaller reclaimed HFC quantities and considered reclaimed (which would not create a sustainable supply of reclaimed materials as the supply of virgin HFCs continues to decrease, and would disincentivize investment in fractional distillation capacity), and encouraged EPA to further tighten this requirement because the 15 percent limit was established in the California context and that a stronger limit may be feasible on a nationwide basis while also supporting the smaller reclaimers to continue expanding and developing their capacity for advanced reclamation of HFCs. Another commenter expressed concern that setting an allowance (*e.g.*, 15 percent) for inclusion of newly produced refrigerant to be incorporated into reclaimed refrigerant is not a credible structure and will result in greenwashing claims, arguing that only recovered refrigerant should be considered reclaimed. The commenter further argued that setting such a limit for newly produced refrigerant could thwart the goal to maximize reclaim and narrow uses away from clever solutions like a "service gas" with an increasing percentage of reclaimed refrigerant as more reclaimed refrigerant becomes available over time.

Another commenter stated that they supported the definition of reclaimed refrigerant as containing no more than 15 percent virgin material but would also support a lower or much lower limit because only a few larger reclaimers who were also importers, blenders, and distributors received substantial HFC allowances. The commenter further stated that many reclaimers received small or no allowances, and that allowances provided to reclaimers are being reduced as reclamation expectations are being raised. The commenter concluded that that most reclaimers would not be able to access 15 percent virgin material for a blend even if they wanted or needed to. The commenter further noted they did not support the concept that reclaimed refrigerant could be any percentage and treated as a blended component in a larger lot of refrigerants, arguing that this concept is not reflective of how reclaimed refrigerant is produced today and opens the door to non-reclaimers to find creative solutions to dilute the value of reclaimed refrigerant.

Response: EPA acknowledges these commenters' support and requests for potentially tightening the limit for virgin HFCs in reclaimed HFC refrigerant. The Agency understands that a portion of virgin HFCs is often necessary for rebalancing particular refrigerant multi-component blends, and, in contrast, EPA understands that single-component HFCs that are reclaimed would not require additional high-purity (*e.g.*, virgin) HFCs for the purposes of rebalancing. EPA also understands that different reclaimers deploy different practices (*e.g.*, not all reclaimers use factional distillation), and may see different needs for using the maximum allowable percentage of 15 percent, by weight virgin HFCs. For example, some reclaimers may have capabilities and technologies to reclaim particular multi-component blends from difficult to separate mixed recovered refrigerants and may not need to use the full 15 percent limit, by weight, of virgin HFCs. Other reclaimers may have limited access to these technologies and might routinely meet the maximum allowable amount of virgin HFCs in reclaimed HFC refrigerants they process and sell. With these considerations, the Agency views the 15 percent limit, by weight, on virgin HFCs as appropriate and disagrees that it is appropriate at this time to establish a lower limit on virgin HFCs or that reclaimed HFC refrigerants may only constitute recovered materials. However, the Agency notes that it may revisit this requirement in the future.

Further, The Agency does not agree with the need to and is not establishing different standards for different reclaimers based on technology used to achieve the required purity standards for reclaimed refrigerants. EPA is establishing a single reclamation standard to ensure that reclaimed HFC refrigerants sold contain to a consistent amount of virgin HFCs (*i.e.*, 15 percent, by weight). Establishing a varying standard might produce adverse effects for reclaimed HFC refrigerants placed on the market such that reclaimed HFCs of varying amounts of virgin content may be valued differently by purchasers. EPA also notes that the limit of 15 percent, by weight, of virgin HFCs in reclaimed HFC refrigerant was established after consideration of meeting the goals of subsection (h) the AIM Act to maximize reclaim of HFCs.

EPA acknowledges concerns related to "greenwashing" and improperly claiming benefits associated with reclaimed refrigerants. The Agency's view is that the established limit of 15 percent, by weight, for virgin HFCs in reclaimed HFC refrigerants is appropriate at this time, as explained earlier in this response. EPA considers the required label and other requirements established in this rule as one means of countering false claims of benefits related to refrigerants that contain a higher proportion that permitted of virgin HFCs. To the extent that one of the commenters claims that allowing any virgin HFCs in reclaimed refrigerant would lead to greenwashing claims, EPA disagrees. The requirements established in this rule provided clarity about the extent to which reclaimed refrigerant can contain virgin HFCs and are designed to ensure that all reclaimed refrigerant meets the same minimum standards. The Agency will monitor the marketing of refrigerants and may consider revising or adding to these requirements in the future if warranted.

EPA acknowledges that some, but not all, reclaimers are allowance holders. EPA does not view not having allowances as a barrier to reclamation. To the extent that reclaimers use high purity refrigerants in their reclamation process (*e.g.*, for rebalancing blends), even if they do not have allowances, they could purchase virgin HFCs in the domestic market or other high purity (*e.g.*, previously reclaimed) refrigerant, which may or may not go through some degree of reprocessing, until the final product meets the purity specifications to be considered reclaimed. EPA is unclear as to how non-reclaimers would dilute the reclamation market based on the comment; however, EPA responds to concerns with the potential for a non-reclaimer to market refrigerant as reclaimed by noting that the requirements finalized in this action, including the labeling and recordkeeping requirements, apply to any refrigerant that is sold as reclaimed.

Comment: One commenter supported the 15 percent virgin allowance for reclamation but sought clarification on the calculation of this value. The commenter was unclear how the calculation for reclaimed refrigerant would be performed, especially when the reclaimed material includes non-HFC refrigerants. The commenter was uncertain whether the non-HFC substances would be included in the weight of the reclaimed refrigerant batch and recommended not including non-HFC components towards the minimum 85 percent by weight of reclaimed HFCs. The commenter additionally suggested a tolerance limit for the measurement or calculation of the 15 percent or 85 percent.

Response: Consistent with the proposal, EPA is clarifying that in the case of reclamation of a refrigerant blend that contains an HFC and a non-HFC component (*e.g.*, an HFO) that is being reclaimed, the 15 percent limit for virgin materials only applies to the HFC component of the blend. When calculating the amount of virgin HFCs that would allowed, the 15 percent limit, by weight, would apply to the weight of the HFC component(s), not the total weight of the reclaimed refrigerant.[85] EPA further clarifies that the 15 percent limit on virgin HFCs does not apply per HFC in the case a reclaimed refrigerant blend contains more than one HFC component. Rather, the 15 percent limit on virgin HFCs should be calculated as 15 percent of the weight of the total HFC components in the blend.[86] EPA notes that subsection (h)(1) of the AIM Act

[85] As an illustrative example, if a refrigerant blend is composed of 50 percent HFC and 50 percent non-HFC and one is seeking to reclaim 100 pounds of this refrigerant, the 15 percent limit on virgin HFCs would apply to just the weight of HFC portion, or 7.5 pounds (*i.e.*, 15 percent of 50 pounds).

[86] As an additional illustrative example, suppose 100 pounds of a refrigerant contains 20 percent of HFC A, 30 percent of HFC B, and 50 percent of a non-HFC component is to be reclaimed. The 15 percent limit on virgin HFCs would apply to just the weight of sum of the HFC components. In this example, the total weight of HFCs is 50 pounds and the allowable weight of virgin HFCs would be 7.5 pounds (*i.e.*, 15 percent of 50 pounds). The limit on virgin HFCs may be made up of a combination of weights of virgin HFC A and HFC B that total 7.5 pounds (*e.g.*, 7.5 pounds of virgin HFC A and zero pounds of virgin HFC B; 3.5 pounds of virgin HFC A and 4 pounds of virgin HFC B; etc.).

provides authority to promulgate regulations to control, where appropriate, practices, processes, or activities related to the servicing, repair, disposal, or installation of equipment that involves reclaiming of a substitute for a regulated substance used as a refrigerant. EPA interprets this provision to provide it authority which could include requiring, where appropriate, the use of reclaimed HFC substitute refrigerants in practices, processes, or activities related to the servicing, repair, disposal, or installation of equipment. However, at this time, the Agency is not establishing a requirement for the non-HFC component of a blend to be reclaimed and thus is not establishing a standard limiting the amount of virgin material for reclaimed substitutes for HFCs. While EPA acknowledges that there is some degree of random and systematic error associated with measurement devices, EPA is not implementing a tolerance range for this provision at this time and does not agree that one is necessary.

Comment: One commenter supported the 15 percent, by weight, virgin allowance for reclamation but proposed basing the reclaimed content on CO_2 equivalency values to allow the market under the Allowances and Technology Transitions programs to better move to low-GWP refrigerants in a cost-effective and environmentally positive manner. The commenter recommended allowing the destruction or repurposing of one refrigerant to be credited with a carbon allowance and to allow an equivalent quantity of another refrigerant to be placed on the market as reclaimed, minus a 10 percent offset for a net reduction in CO_2 equivalents, to create a new market outlet for high-GWP substances and ensure that leaks are minimized. The commenter provided examples where a smaller mass of high-GWP substances could be reclaimed and a larger mass of low-GWP substances placed on the market as reclaimed material by relying on the substances' CO_2 equivalents.

The commenter stated that HFC-32 and HFC-152a use in blends is vital to the survivability of the industry as we phasedown HFCs under the Allocation rulemaking and go through the transition required by the 2023 Technology Transitions rulemaking. The commenter stated that if EPA adopts a strict weight (mass) basis, industry will face an extreme burden sourcing HFC-32 and HFC-152a. The commenter noted that all formulations of viable heat pump solutions are based on some content of HFC-32, and that the vast majority of HFC-32 in the current marketplace is in the form of R-410A. The commenter stated that it is correct to assume that material will be used to service that market and HFC-32 will not become available for use in R-454B service or in commercial refrigeration service/initial fill. Further, the commenter mentioned that the fact that HFC-32 and HFC-125 make an azeotrope at a composition not too far from R-410A makes the separation of HFC-32 from HFC-125 non-trivial to recover the HFC-32 via distillation. The commenter stated that the viable solution is to minorly reconstitute and return "certified reclaimed material" to the market for service of existing equipment aging out of the marketplace.

Response: EPA did not propose and is not establishing an offset or GWP-based program as the commenter suggests. The Agency recognizes that the 2023 Technology Transitions Rule uses GWP thresholds and that the Agency issues allowances based on exchange values. However, for the purposes of establishing an ER&R program, and more specifically for establishing provisions for the upper limit on virgin HFCs used in reclaimed HFCs, the Agency does not agree with the asserted need for an offset or GWP-based approach. In establishing this and other requirements related to the use of reclaimed refrigerants in this rulemaking, the Agency seeks to require actions that would help meet the purposes described in subsection (h)(1) of the AIM Act, including maximizing the reclamation of HFCs. Thus, the destruction or repurposing without reclaiming of any HFCs, including high-GWP HFCs that can be properly reclaimed would be counter to this goal. Further, other provisions of the AIM Act prescribe a phasedown, and not a phaseout for regulated substances. Even after the phasedown reaches its final step, virgin HFCs will continue to be produced and consumed. Any destruction-based program to provide offsets or credits would need to fully assess and address additionality. While such programs and considerations are beyond the scope of this rulemaking, EPA is uncertain additionality could be addressed in these types of programs. The Agency also does not agree with a GWP-weighting approach for virgin HFCs allowed in reclaimed HFCs. The Agency proposed and is finalizing a requirement that is based on percentage, by weight. The Agency understands that for servicing equipment, it is important to maintain adequate supply of the same refrigerants used in that equipment when it was initially charged. So, unlike the 2023 Technology Transitions Rule facilitating transition to next-generation technologies through sector-based restrictions on HFCs, this rule concerns the goals of maximizing reclamation and minimizing releases from equipment. Availability of refrigerants of all types, increasingly from reclamation, is central to meeting the goals of this rule.

The Agency recognizes the use of HFC-32 and HFC-152a neat and in blends. The Agency further understands that as the market evolves, the sourcing of HFCs to be reclaimed may require separating HFCs and then using those separated HFCs in new blends. EPA is aware that a number of reclaimers have invested and currently operate advanced reclamation technologies to effectively reclaim refrigerants, including separating and reclaiming HFC-32 from R-410A. For additional discussion on supply of reclaimed HFCs, please refer to comments and responses in section IV.E.2.

Comment: Another commenter, as part of their suggestion that EPA replace the reclaim mandates for initial fill and servicing with a requirement that refrigerant supplied for servicing include a specified percentage of reclaimed material on a CO2e basis, proposed that this requirement should be met on a net basis, allowing for certified reclaimed refrigerant to be blended with virgin refrigerant in any ratio so long as the final ratio of material placed into the market in every reporting year meets the ratio as determined by the Administrator. The commenter argued that this flexible requirement would allow a supplier to provide 100 percent virgin R-410A, but 100 percent reclaimed R-404A, HFC-134a, or other refrigerant types, so long as the net CO_2e is met.

Response: The Agency does not agree with the commenters suggestion to base the 15 percent on an annual basis. The Agency discussed elsewhere in this section that it is applying the requirement on a batch basis.

Comment: EPA received many comments that opposed the 15 percent, by weight, limit for virgin HFCs in reclaimed HFC refrigerants. Two commenters stated the requirement should be removed. One such commenter opposed any cap on virgin HFC refrigerants and specifically opposed the 15 percent blanket cap which they stated was arbitrary and capricious. The commenter argued that similar provisions at a state level (*i.e.*, CARB regulations) was reached after industry input for R-410A, and EPA did not solicit detailed technical input before the 15 percent proposal and that CARB's 15 percent limit cannot be assumed to correlate for other multicomponent HFC blends. The commenter claimed that the limit could cause certain equipment to be prematurely obsolete if it uses HFCs for which the 15 percent limit is unworkable and that EPA did not consider technical factors in tandem with the HFC phasedown. The commenter stated that EPA must demonstrate that the limit is uniformly technically achievable based on limitations of reclaimers and across the spectrum of HFC blends currently in the market and will result in increased reclamation beyond regulatory and market factors already identified by EPA to meet its mandate under subsection (h). The commenter claimed that small reclaimers cannot separate mixed or out of ratio refrigerants, resulting in the destruction of many refrigerants. The commenter stated that greater reclamation could be realized if small reclaimers could use virgin refrigerant at their discretion to meet purity standards while not yielding more reclaimed refrigerant than they received. The commenter disagreed that a virgin HFC limit was necessary given the decreasing pool of virgin HFC.

Another commenter claimed that the 15 percent virgin material limit for reclaimed material effectively removed blending as an option for creating certified refrigerants from mixed HFCs. The commenter stated that fractional distillation is not realistic for small businesses due to its cost and time required, and that new technologies to address mixed HFCs are still nascent. The commenter contended that reclaimers receive many mixed HFCs and that the 15 percent limit would remove any benefit of blending.

One commenter argued that the 15 percent, by weight, virgin HFC requirement would require an unattainable amount of material in 2028. Based on several assumptions, the commenter estimated that only four percent of the total demand for R-410A could have been met in 2022 based on the 15 percent virgin requirement. The commenter also stated that frequently, a small amount of reclaimed mixed refrigerant is added to virgin refrigerant to blend out mixed gas, not the other way around. Using a very high reclaim to virgin ratio as the standard for reclaimed gas will reduce reclaimer’s ability to process more mixed gas into salable product.

Response: EPA acknowledges these comments related to the limit on virgin HFCs in reclaimed HFC refrigerants. The Agency concludes that such a limit is necessary for helping to achieve the purpose identified in subsection (h) of the AIM Act to maximize the reclamation of HFCs because without such a limit refrigerant could be marketed as reclaimed that contained little recovered HFCs. Reclaim and reclamation are defined in subsection (b)(9) of the AIM Act to mean the reprocessing of recovered HFCs to a particular purity standard and the verification of the purity of that HFC using at a minimum a specified analytical methodology. Establishing a limit on virgin HFCs helps to ensure that reclaimed HFCs effectively make use of recovered HFCs and also helps promote more recovery of used HFCs from equipment that can then be reclaimed. This is an important part of maximizing reclamation of HFCs because those recovered HFCs are a key component of reclaimed refrigerants. Accordingly, EPA disagrees with the assertion that greater reclamation would result from an approach that allowed reclaimers to use as much virgin HFC as they wished in producing reclaimed HFCs. EPA does not agree with the comments asserting that the Agency must demonstrate that the limit is uniformly technically achievable for current reclaimers and across the spectrum of HFC blends in the market and will result in increased reclamation beyond regulatory and market factors to meet its mandate under subsection (h). From information provided in comments to the NODA and based on EPA's understanding, HFC reclamation can be complex and require advanced separation technologies. EPA understands that reclaimers have access to varying degrees of these technologies for the reclamation of HFC refrigerants. Based on information provided to the Agency in comments to the NODA, in public meetings, and in comments for this rulemaking, EPA is aware that reclaimers are currently using technologies that can meet the provisions of this rulemaking. The statutory text of subsection (h) does not include requirements for uniform technical achievability, and EPA interprets the references in subsection (h)(1) to maximizing reclamation to include authority to establish provisions that require reclaimers to go beyond their current practices to achieve that goal, when such requirements are otherwise consistent with the direction in subsection (h)(1). EPA also interprets subsection (h)(1) as authorizing regulations that help ensure that the reclamation that may be anticipated based on other regulatory or market factors, such as a decreasing pool of virgin HFCs, actually occurs and meets a uniform standard. In EPA's view, such regulations can be part of the overall effort to maximize reclamation, consistent with subsection (h)(1).

Further, establishing such a standard helps to ensure that reclaimed HFCs are a consistent product on the market. The Agency understands that reclaimers have a varying types of reclamation technology; however, the Agency does not agree that reclamation primarily by blending is an effective method to achieve the purposes identified in subsection (h) and in particular maximizing reclamation. As noted by some comments, such a practice can result in refrigerants that contain relatively small amounts of reclaimed material being sold or marketed as reclaimed. Moreover, the Agency is not precluding the practice of blending itself, such that the 15 percent limit, by weight, of virgin HFCs is not exceeded. Highly pure reclaimed HFCs and up to 15 percent virgin HFCs can be used for such purposes. The definition of reclaim/reclamation in the subsection (b)(9) of the AIM Act states that reclamation involves the "reprocessing of a recovered regulated substance." Consistent with this definition, recovered regulated substances must undergo some degree of reprocessing to be reclaimed, and the Agency does not view achieving the required purity standards by solely blending with virgin HFCs to constitute reprocessing the recovered materials. Thus, blending with virgin HFCs would be a practice performed together with other measures to reprocess recovered HFCs to achieve the required purity standards. Furthermore, placing a limit on the maximum allowable virgin HFCs in reclaimed HFCs ensures a consistent understanding among the regulated community of what reclaimed HFCs are.

EPA acknowledges that it referenced the Refrigerant Recovery, Reclaim, and Reuse Requirements (CARB Program) or R4 Program while proposing a limit on virgin HFCs in reclaimed HFCs, as well as other applicable information. As the commenters state, that the limit on virgin HFCs established by CARB for California were developed after consultation with industry. EPA proposed, requested comment, and is finalizing a broader program that was informed, in part, by the experience in California. EPA recognizes that the R4 Program in California was more limited in scope to focus on reclaimed R-410A, and that industry input on the state program was largely focused on this. The Agency is finalizing the requirement for a limit on virgin HFCs in reclaimed HFC refrigerants for all reclaimed refrigerants that containing HFCs. This requirement is being established to drive and promote reclamation as consistent with purpose in subsection (h)(1) for the maximizing of reclamation of HFCs. In response to the comment that EPA did not solicit technical input before the 15 percent proposal, EPA notes that the Agency solicited comment on establishing different percentages for a limit on virgin HFCs (*e.g.*, if a lower percentage could be used). Commenters had the opportunity to provide technical information during the public comment period for this rulemaking, many commenters did so, and that EPA has considered those comments in finalizing this requirement.

Comment: Another commenter stated that EPA failed to consider areas where the proposed regulations duplicate existing regulations or less burdensome and costly alternatives, claimed that there are less costly and less burdensome regulatory alternatives for EPA to continue to implement Congressional directives under the AIM Act, and argued that EPA's cited objectives in the proposed rule have already been achieved by an aggressive HFC phasedown schedule. The commenter stated that EPA estimates the overall compliance costs of the proposed rule to be well in excess of $3 billion, and stated that under the Unfunded Mandates Reform Act (UMRA), before promulgating any rule that may result in expenditures, in the aggregate, of $100 million or more, an agency must "identify and consider a reasonable number of regulatory alternatives and from those alternatives select the least costly, most cost-effective or least burdensome alternative that achieves the objectives of the rule." The commenter further argued that EPA has not shown that it considered the current market dynamics, let alone any less burdensome and less costly alternatives, before proposing onerous new requirements applicable to reclaimers, and claimed that EPA's proposed rule goes too far and is not tailored to achieve the goals of subsection (h) in the least costly, most cost-effective, or least burdensome manner, as required under UMRA. The commenter also argued that EPA has not presented any evidence to show that proposed reporting and recordkeeping requirements will increase opportunities for reclamation beyond what will occur from market dynamics. The commenter stated that in short, if there is a less burdensome alternative that will accomplish EPA's stated objectives, then the Agency is obligated to consider and adopt it unless another alternative exists that is even less costly or burdensome. The commenter further stated that it was not apparent that the type of scenarios they listed or the associated costs were considered by EPA in developing its cost estimates, and that EPA failed to consider how existing regulations, policies and practices, and alternative approaches to address concerns regarding mischaracterization of HFC refrigerants, would be more effective, less costly, and less burdensome. The commenter also argued that proposed the 15 percent limit on virgin HFC refrigerants in reclaimed refrigerants is a sharp departure from past interpretations and will result in significant costs without adequate technical or legal justification, and that many small reclaimers do not have capabilities to separate mixed or out of ratio refrigerants, meaning that the 15 percent limit will be difficult or impossible to meet for some small reclaimers and the result could be that many used refrigerants will be destroyed, which the commenter stated would undermine the AIM Act's directive to maximize reclamation and will also result in significantly greater costs to the regulated community which EPA has not considered. The commenter argued that the proposed cap will impose unjustified costs and burdens on all reclaimers and their customers that do not appear to have been fully considered by EPA. The commenter claimed that for EPA to meet its legal burden in proposing this rule, it must demonstrate that its proposed limit is uniformly technically achievable, and adoption of this limit will result in increased reclamation beyond the regulatory and market factors EPA has already identified, to meet its mandate under subsection (h), and that EPA must also demonstrate under UMRA that this is the least costly, most cost-effective, and least burdensome option. The commenter further argued that EPA provided no evidence that container tracking, marking and certification will serve to maximize reclamation, minimize releases, or protect technicians and consumers beyond what is accomplished by existing requirements, nor has the Agency demonstrated that its proposed requirements are the least costly and burdensome options. The commenter stated that small business grant programs, which could help, have yet to be established and are subject to appropriations availability.

Response: EPA disagrees with these commenters' assertions as described in this response. EPA extensively considered the legal and technical basis of formulating a reclamation standard provision under subsection (h), as described in the proposed rule and in this final action. As previously stated, EPA consulted with stakeholders before the notice of proposed rulemaking (NPRM), through the opportunities for public comment on the NPRM, and anticipates continuing engagement after the rule is finalized. Notably, in October 2021, EPA released a draft report "Analysis of the U.S. Hydrofluorocarbon Reclamation Market: Stakeholders, Drivers, and Practices," accompanying a NODA (87 FR 62843, October 17, 2022). EPA solicited stakeholder feedback and held a public stakeholder meeting shortly after the NODA was published on November 9, 2022. EPA received eleven comments in response to the NODA as detailed above. EPA does not agree that the 15 percent limit on virgin composition is not technically achievable and discusses in other responses in this section and in section IV.E.2 the technical capabilities of reclaimers and the available technologies that are current in use. Further, EPA received comments to the NODA stating the use of these technologies (*e.g.*, fractional distillation) is feasible, and the Agency is aware of reclaimers expanding capacity of these technologies to process increased volumes of reclaimed HFCs. EPA determined that a 15 percent limit on virgin material is technically feasible and received comments agreeing with that conclusion. EPA considered alternatives to the reclamation standard, and determined that the 15 percent limit is a way to ensure a consistent understanding among the regulated community of reclaimed material. From a legal perspective, the Agency concludes that the reclamation standard is an important part of ensuring that the reclaimed HFCs that are used to comply with the requirements to use reclaimed material are in fact chiefly constituted of reclaimed material, thus helping to ensure that these requirements serve the intended objective of maximizing reclamation, consistent with the purposes identified in subsection (h)(1). To the extent the comment suggests that EPA must provide evidence that the reclaim requirements will substantially increase opportunities for reclamation beyond what would occur from market dynamics or that they be uniformly technically achievable, EPA does not agree that subsection (h) requires such evidence as a prerequisite to regulation, for the reasons discussed in the prior response to comment. In response to the comment regarding reporting and recordkeeping requirements, EPA notes that those requirements are focused on ensuring compliance with other requirements established in this rule that help to maximize reclamation but are not designed to independently increase opportunities for reclamation.

With respect to the Unfunded Mandates Reform Act (UMRA), the Agency's proposed action complied with the requirements under UMRA that applied at proposal. Due to EPA narrowing requirements in the final rule, as well as the estimated impacts of the 2023 Technology Transitions Rule in reducing the amount of projected future stocks of refrigerant-containing appliances using an HFC or HFC substitute with a GWP greater than 53, the estimated compliance costs of the final rule are significantly lower than what the proposed rule's estimated compliance costs were. As noted elsewhere in this preamble, this final action does not contain an unfunded mandate of $100 million or more as described in UMRA, 2 U.S.C. 1531–1538, and does not significantly or uniquely affect small governments. Thus, the requirements related to the adoption of the least costly, most cost-effective or least burdensome alternative that meets the objectives of the rule under UMRA do not apply to this final action.

Given the importance of the 15 percent cap in helping to achieve the regulatory objective of maximizing reclamation, EPA does not agree that any costs or burdens that may be experienced by reclaimers or customers are unjustified. While not used for decision-making purposes, EPA notes that its analysis of the impacts of this provision is discussed in the RIA addendum. EPA disagrees with the commenter's assertion that the objectives of this rule—which addresses requirements under subsection (h) of the AIM Act—would already be achieved by previously established regulations pertaining to separate statutory requirements of the AIM Act. As detailed in the RIA addendum, EPA evaluated multiple scenarios regarding incremental impacts of this rule relative to actions that industry may or may not undertake in the baseline.

EPA has presented results of the more conservative of these scenarios in this preamble. However, even in this more conservative scenario in which industry is assumed to undertake some improvements to leak repair and refrigerant recovery in the absence of this rulemaking, the rule is estimated to have significant additional impacts. EPA also notes that estimated compliances costs resulting from the final rule are significantly lower than those assessed for the proposed rule, due to a narrowing of requirements in several areas. EPA reiterates that this rulemaking is designed to serve the purposes identified in subsection (h)(1) of the AIM Act of maximizing reclamation and minimizing the release of regulated substances. While, as noted previously in this preamble, EPA has included estimates of the costs and benefits of this rulemaking in the RIA addendum to provide the public with information on the relevant costs and benefits of this action and to comply with Executive Orders, nothing in the AIM Act requires EPA to consider costs or identifies any particular cost-based metric or analytical approach for use in evaluating and establishing regulations to implement subsection (h). The commenter correctly stated that subsection (h) of the AIM Act does include a small business grant program that is subject to appropriation availability. Subsection (h)(5) provides this program for the purchase of new specialized equipment for the recycling, recovery, or reclamation of a substitute for a regulated substance, including the purchase of approved refrigerant recycling equipment for recycling, recovery, or reclamation in the service or repair of a MVAC systems. Funds have not been appropriated for this grant program and the establishment of this program is outside the scope of this rulemaking.

Comment: One commenter questioned why contractors seem to de-select reclaimed refrigerants, noting the differences between the AHRI 700 standard and new refrigerants supplied with 99.99 percent purity and precision blending. The commenter suggested EPA consider upgrading the specification to match the current supply of virgin refrigerants.

Response: In response to the commenter's question regarding use of reclaimed refrigerants in the RACHP sector, EPA notes that certain ODS may only be available as reclaimed for use in particular applications with the ODS phaseout. For example, since 2020, only reclaimed HCFC-22 can be used to service appliances in the RACHP sector. The same is true for appliances using CFCs since the 1990s. The Agency is not aware of any concerns from RACHP servicing industry stemming from these requirements. The Agency considers this example and the broader ODS reliance on reclaimed ODS as informative in the context of this rulemaking.

EPA acknowledges that both reclaimed and virgin HFCs are required to meet the AHRI 700 purity standard and that even with compliance with the AHRI 700 purity standard, there may be minor differences between reclaimed and virgin refrigerant (such as moisture content) but these minor differences do not impact the functionality of the reclaimed refrigerants in equipment nor do they suggest marked differences between reclaimed and virgin refrigerants as both are required to at minimum reach AHRI 700 levels of purity. These differences should not impact the equipment that uses these refrigerants. Accordingly, EPA is not making any change to the applicable specifications to match the current supply of virgin refrigerants in this final action.

Comment: One commenter requested that EPA acknowledge the unique challenges of returning diverse blends to ASHRAE specifications without blending a significant amount of virgin content. The commenter cited five- and three-component refrigerant blends that may be challenging to return to their nominal composition, require more than 15 percent virgin refrigerant, or use an HFC that is rarely used and therefore not recovered in sufficient quantities.

The commenter recommended increasing the permissible virgin percent composition to avoid eliminating ASHRAE A1 refrigerants that comply with the 2023 Technology Transitions Rule. Another commenter supported EPA's 15 percent virgin content standard for refrigerant blends with fewer than three components but recommended 65 percent reclaimed content and 35 percent virgin HFCs for blends with three or more components to account for minor additions in certain products and issues with leak fractionation. Two commenters recommended phasing in the virgin refrigerant limit over several years. One of the commenters recommended starting with a 90 percent virgin product in 2028 and progressing to the 15 percent limit. The commenter noted this would enable the market to adjust.

Response: EPA acknowledges these comments on multi-component blends. EPA is not establishing varying percentage limits for virgin HFC refrigerant based on the number of components in a refrigerant blend or a phase in approach by percentage. As explained in prior responses, the Agency is establishing an upper limit for virgin HFCs in reclaimed HFCs of 15 percent by weight. EPA acknowledges the reclamation challenges in working with blends, and in particular with three or more component blends. The Agency notes that there are technologies available to effectively reclaim such blends and reclaimers with the technical capability to do so. Given the availability of such technologies and for reasons explained elsewhere in this preamble and responses to other comments, EPA considers the 15 percent upper limit for virgin HFCs to be technically feasible commensurate with the compliance date.

EPA also considers a 15 percent limit to better serve the purpose identified in subsection (h)(1) of the AIM Act of maximizing reclamation than using a higher percentage would. Further, the compliance date provides time for the reclaimers and the market to adjust. Therefore, EPA is not establishing a phased-in approach. Lastly, EPA acknowledges there are some blends that rely on rarely used HFCs, including newer blends such as certain ASHRAE A1 refrigerant blends that are compliant with certain restrictions under the 2023 Technology Transitions Rule. However, the Agency is only establishing requirements for the use of reclaimed HFCs in servicing or repair of equipment in three subsectors, that will primarily require reclaimed HFCs and blends that use components that have been common for many years (and in some cases, even decades). As noted in the 2024 *Updated Report - Analysis of the U.S. Hydrofluorocarbon Reclamation Market: Stakeholders, Drivers, and Practices*, R-410A, HFC-134a, and R-404A are the most common HFCs/HFC blends in the current stock of installed equipment, by mass. The Agency also reiterates that the limit on virgin materials only covers the HFC portion of a blend and refers to a previous response on calculating the allowable mass of virgin HFCs in a previous response as it relates to blends that contain an HFC and non-HFC component or more than one HFC component.

Comment: One commenter recommended adding "and HFC substitutes" to proposed reclaim rules to avoid replicating past regulatory gaps which led to environmental consequences and provide for comprehensive refrigerant management. The commenter stated that the addition of substitutes would avoid disparities and possible misinterpretation. The commenter stated that, if HFC substitutes are not held to the same standard, concerns about mishandling, venting, and ownership will be likely. Another commenter advocated for a mandatory reclamation of all refrigerants in the United States, excluding hydrocarbons. The commenter noted that many HFC substitutes are HFCs themselves and cited the AIM Act's requirement that EPA maximize reclaim and minimize release of HFCs and their substitutes. The commenter anticipated that transitioning to HCFOs or other chemicals could pose environmental concerns without sufficient life cycle management plans, including limiting releases, suggesting that all refrigerants be collected and transported to an EPA-certified reclaimer.

Response: EPA is clarifying, that for the purposes of this regulation, the Agency is defining the term "substitute for a regulated substance" to explicitly establish for purposes of the regulations established in this rulemaking under 40 CFR part 84, subpart C that substitutes for HFCs are substances that are not HFCs. EPA recognizes in the context of other rulemakings under the AIM Act (*e.g.*, 2023 Technology Transitions Rule), substitutes may be used to refer to a lower-GWP substance which may or may not include HFCs or blends containing HFCs. In this context of this rulemaking, EPA is using a different definition to help distinguish between those requirements that apply to HFCs and those that apply to substitutes for HFCs. EPA is establishing, as proposed, to not include required limits on the amount of virgin substitutes for HFCs in reclaimed refrigerant, whether neat or in blends. This exception is not a blanket exception from all aspects of this rule or other related regulations. For example, all regulated substances and non-HFC substitutes for HFCs with GWP greater than 53 would be subject to the leak repair requirements established in this rule. Further, EPA notes that HFCs and certain substitutes for HFCs, including HFO and HCFO refrigerants, are not exempt from the venting prohibition under 40 CFR 82.154, and it is illegal to knowingly vent or otherwise release such refrigerants into the environment while maintaining, servicing, repairing, or disposing of an appliance or IPR. EPA is aware that substitutes for HFCs are increasingly being used in certain RACHP subsectors and are commonly used in refrigerant blends with HFCs. Any refrigerant blend that contains an HFC would be subject to the leak repair requirements in this rulemaking, which are being established consistent with the purposes identified in subsection (h) of the AIM Act of minimizing releases of regulated substances. EPA decided to limit the requirements that apply to substitutes for HFCs in this rule to those substitutes for HFCs with GWPs above 53 for reasons articulated in this final rule and in the proposal. EPA is applying this cutoff as it is the lowest GWP among regulated substances in the AIM Act. Further, the installed stock of these substitutes for HFCs is less prominent than the installed stock of refrigerant-containing equipment with HFCs or refrigerants that contain HFCs. However, the installed stock of these substitutes for HFCs may be important in the future and EPA may reevaluate this decision in the future and may consider applying other aspects of this program to non-HFC substitutes. As noted in a previous response, EPA interprets subsection (h) to authorize regulations that would apply to substitutes for HFCs.

Comment: One commenter noted that reclaimed refrigerant has never needed to be labeled in the industry and stated that requirements to label reclaimed refrigerant would create an additional "product" despite the reclaimed gas being chemically and functionally identical to virgin. The commenter stated that the greatest benefit to reclaimers is if reclaimed refrigerant is marked as fungible with virgin refrigerant. The commenter stated that labeling reclaimed refrigerant could lead to a perception that reclaimed material is of lesser quality and therefore had to be mandated by a federal agency. The commenter claimed this could depress reclaimed gas sales contrary to the AIM Act's direction, and would create confusion about why two different classes of refrigerant exist in the market. Another commenter opposed the recordkeeping and labeling requirements and claimed that there was no clear need to ensure that reclaimed refrigerants are easily recognized by servicers because technicians only need assurance that the material meets appropriate specifications for the particular HFC or HFC blend. The commenter stated that requirements for reclamation occurring at the batch level further reduced the meaning of the proposed container marking requirements. The commenter stated that compliance with EPA's proposed mandate was the only reason servicers would need to distinguish between reclaimed and virgin material. The commenter suggested that EPA should instead clarify that for current reclaimer reporting that a reclaimer's annual total reported reclamation should match the reclaimer's reported annual total of recovered input minus waste, which could be a less burdensome alternative that the Agency should consider. A third commenter recommended the use of a label or QR code to disclose the amount of bona fide recovered refrigerant in reclaimed material. The commenter advocated detailed data on chain of custody to avoid false claims and illegal trade, with a "credible paper trail throughout its return to service."

Response: EPA acknowledges that this labeling requirement is new and may vary from current practices. The Agency disagrees that the labeling requirements would designate refrigerant as being inferior to virgin refrigerant and disagrees with the commenter's description of the perceived rationale for a federal agency mandate. The Agency was clear in the NPRM and in this final rule that reclaimed refrigerant is capable of performing the same functionality of virgin refrigerant in equipment. Both are required to meet the exact same purity standard (*i.e.*, based on AHRI 700). The labeling requirements are being established to support the required uses of reclaimed refrigerants and to indicate that the reclaimed refrigerant contains no more that 15 percent, by weight, virgin HFCs, thus promoting a consistent understanding of what reclaimed refrigerants are. Given the requirements to use reclaimed HFCs in servicing and repair of certain equipment in this final action, labeling will help regulated entities comply with those obligations. Thus, EPA disagrees with the comment that there is no need for technicians to be able to easily recognize reclaimed refrigerant. As such, the labeling requirement helps to support the purpose identified in subsection (h) of the AIM Act to maximize reclamation.

The Agency further notes that use of similar labels that indicate use of recycled materials is common practice through a wide range of industries and products. Many consumers value and seek out recycled materials or products. The requirements that both virgin and reclaimed HFC refrigerants must meet the same standards for purity based on AHRI-700 is relatively new, and in fact EPA regulations under CAA section 608 only applied the requirement to meet the AHRI 700 purity standard to reclaimed refrigerants.[87] EPA acknowledges that some applications have more stringent requirements than AHRI 700 (*e.g.*, metered dose inhalers) and there may be contractual arrangements that limit entities to suppliers of virgin or reclaimed refrigerant only at this time. However, as noted throughout this final rule, as the phasedown of the production and consumption of virgin HFCs continues, demand for reclaimed HFC refrigerant will grow. Thus, the required label will provide pertinent information to purchasers and users of refrigerants and help them to select a refrigerant that meets their needs in particular situations. EPA responds that commenter's concern that a new label could signal a new separate "product" seems unfounded given all reclaimed HFCs will be required to be labeled as such and there is an overall requirement for labeling of HFCs. Further, EPA is aware of at least one reclaimer that specifically markets a line of refrigerants as reclaimed refrigerant.

EPA acknowledges the comments raising chain of custody concerns. EPA is imposing recordkeeping requirements providing the name, address, contact person, and the phone number of the reclaimer certified under 40 CFR 82.164, as well as information about the date the container was filled, and the amount of the regulated substance in the container. Batch and

[87] EPA recently finalized a requirement that all HFCs (both virgin and reclaimed) imported, filled in containers domestically, and sold as refrigerants meet the specifications in appendix A to subpart F of part 82—Specifications for Refrigerants, see Allocation Framework Rule at *https://www.federalregister.gov/d/2021-21030/p-679*.

substance identification information is included in these requirements along with the percent by weight of the virgin regulated substances. The labeling and certification requirements in this rulemaking help to ensure that purchasers and users of reclaimed refrigerant are receiving and/or using a product that has been verified to be reclaimed to the proper purity, as well as meeting the 15 percent limit on virgin HFCs.

Comment: Many commenters commented on limiting recovered and reclaimed material to substances removed from equipment or systems in the United States. One of the commenters stated that limiting the source of material to the United States would help EPA ensure the quality of material, confirming that only standard-compliant material is utilized, and allow for greater transparency and traceability throughout the reclaim process, facilitating monitoring and enforcement, ensuring the program operates effectively and efficiently. Another commenter stated that illegally traded HFCs will decrease reclamation. One commenter argued that neither reclaimed nor virgin material should be imported for destruction for carbon credit purposes and that EPA should instead prioritize recovery and reclaim in the U.S. market.

One commenter suggested that geographic limits and quality control are necessary to ensure bona fide use and recovery and ensure compliance with the reclamation standard and maximum virgin content. The commenter claimed that incidents of importing virgin refrigerant sold as counterfeit reclaimed refrigerant has been documented under previous ODS phaseout regimes and that requirements to expend allowances for bulk imports does not ensure compliance with the 15 percent limit. The commenter also stated that importers of pre-charged equipment would not be subject to the same allowance requirements. In contrast, the commenter claimed that requirements to use domestically reclaimed refrigerant will be verifiable and enforceable, particularly with the proposed tracking and labeling requirements which will support a strong domestic market. Another commenter questioned how EPA would monitor that refrigerant was reclaimed with the authorized limit of virgin material and suggested that relying on certifications would be an invitation to abuse, especially for refrigerant reclaimed overseas. Another commenter expressed concern that imported refrigerant could be incorrectly labeled as reclaimed if it came from countries with excess production. Conversely, the commenter argued that more profitable exports of recovered refrigerant could starve domestic servicing needs.

Another commenter stated that, without a geographic limitation for reclaimed or recovered refrigerant sourcing, refrigerant recovered abroad will not reduce U.S. emissions nor create market incentives to improve domestic recovery and verifying recovery or reclamation abroad will be very challenging, potentially indirectly advantaging importers of pre-charged equipment sourcing cheaper or even counterfeit material. The commenter also stated that the United States should not aim to receive reclaimed HFCs from the world because Kigali Amendment ratifiers need to implement their own phasedowns and it would be better to reuse HFCs within their countries of origin. The commenter also suggested that there is an incentive for cheating given that importing reclaimed HFC-32 requires fewer allowances than HFC-410A. The commenter encouraged setting up trade agreements for import of reclaimed HFCs where a similar HFC phasedown schedule exists.

Another commenter requested that EPA make clear that reclaimed refrigerant must have been recovered from equipment in the United States or that reclaimed material from outside the United States be allowed only if it was legitimately recovered, disclosed upon import, and followed EPA's current process for legacy refrigerants. An additional commenter suggested that EPA establish standards and a certification process to ensure reclaimed refrigerant is authentic with a known point of origin. Another commenter stated that it is important that importers of pre-charged equipment be required to purchase reclaimed HFCs from EPA-certified reclaimers in the United States, either using reclaimed material to charge equipment in the United States or dry shipping equipment and charging it in the United States. The commenter suggested requiring the dry shipment of equipment to be charged in the United States, to minimize the transport of reclaimed HFCs across countries.

Response: EPA acknowledges these comments regarding the verifiability of recovered and reclaimed HFCs particularly outside the United States. The Agency is not establishing a requirement that recovered or reclaimed HFCs be sourced only from equipment in the United States. With respect to the comment regarding establishing certification and standards, EPA notes that as discussed elsewhere in this notice, the Agency is establishing labeling requirements and certification requirements in this final action. Those requirements are intended to help ensure compliance with the reclamation standard and requirements to use reclaimed material in this final rule. Further, EPA notes that under the requirements previously established in separate regulations in 40 CFR part 84, subpart A, import of any bulk HFCs to the United States, whether virgin or reclaimed, requires expenditure of the requisite number of allowances. Even if commenters are correct about current incentives regarding imports, as the HFC production and consumption phasedown progresses, and the overall quantity of available allowances decreases, importers will need to make decisions about how to expend their allowances and those incentives may shift.

EPA understands that illegal trade of HFCs may decrease demand for refrigerant reclamation, and moreover, is a concern for the successful implementation of the phasedown. Outside of this rulemaking, EPA has already established a multifaceted enforcement approach to deter the illegal import of HFCs. The strong compliance and enforcement system will help preserve the environmental and economic benefits of the HFC phasedown.

With respect to the comments related to other countries' implementation of the Kigali Amendment and the import of virgin or reclaimed material for destruction or carbon credit purposes, the topics are out of scope for this rulemaking and thus these comments require no further response. For additional clarity, the Agency notes that under 40 CFR 84.25, EPA does allow the import of regulated substances into the United States for destruction, subject to a petition process. However, the provisions included in 40 CFR 84.25 are out of scope for this rulemaking.

EPA also received comment that reclaimed feedstocks sourced from the United States should be treated similarly to imports for transformation, with no time limit for how long they can be stored under 40 CFR 84.25, and that domestic reclaimed feedstocks awaiting blending or fractionation should be treated equivalently to HFCs imported for destruction. As noted above, provisions included under 40 CFR 84.25 are out of scope of this rulemaking and thus the comment requires no further response. EPA further notes that the commenter appears to be using the term "feedstock" in a way that diverges from the Agency's use of that term. For example, as explained further in the 2024 Allocation Rule, creating a blend is a completely different process from producing HFCs in the first instance, in which feedstock chemicals are entirely consumed as part of a production process. See 88 FR 46836, 46863 (July 20, 2023).

EPA notes that it is not finalizing the proposed requirements for the use of reclaimed HFCs in the initial fill of new refrigerant-containing equipment in this rulemaking, as discussed elsewhere in this section and in section IV.E of this preamble. Thus, to the extent these comments relate to those proposed requirements for initial fill of such equipment, EPA need not respond further to them in this action. EPA is requiring bona fide use for recovered HFCs that are used to meet the requirements established in this rule related to the use of reclaimed HFCs. Circumventing those requirements by importing charged products and recovering the refrigerant without bona fide use would be inconsistent with the requirements of this final rule.

2. Requirements for servicing and/or repair of existing equipment in the RACHP sector

EPA proposed that the servicing and/or repair of refrigerant-containing appliances in certain subsectors and applications in the RACHP sector where HFCs (whether neat or in a blend) are used would need to be done with reclaimed HFCs starting January 1, 2028. EPA proposed these requirements for refrigerant-containing appliances in the following RACHP subsectors:

- stand-alone retail food refrigeration;
- supermarket systems;
- refrigerated transport; and
- automatic commercial ice makers.

EPA is finalizing this provision with modifications after consideration of the comments. EPA is requiring that the servicing and/or repair of refrigerant-containing appliances in certain subsectors and applications in the RACHP sector where HFCs (whether neat or in a blend) be done with reclaimed HFCs starting on January 1, 2029, one year later than the proposed date of January 1, 2028. Further, EPA is finalizing the requirement to use reclaimed HFCs for the servicing and/or repair of appliances for some (but not all) of the subsectors addressed in the proposal. EPA is not finalizing this requirement for stand-alone retail food refrigeration but is establishing the requirement for appliances in the supermarket systems, refrigerated transport, and automatic commercial ice maker subsectors.

As noted in section I.B, EPA is not finalizing as part of this action the proposed provisions for container tracking of HFCs that could be used in the servicing, repair, and/or installation of refrigerant-containing or fire suppression equipment. However, EPA is establishing a discrete reporting requirement for reclaimers and refrigerant distributors who supply reclaimed HFCs in the affected RACHP subsectors (*i.e.*, supermarket systems; refrigerated transport; and automatic commercial ice makers). EPA is planning to use these data to monitor progress on the volume of reclaimed HFCs available for use in these subsectors ahead of the compliance date for the requirements to use reclaimed HFCs in servicing and/or repair of refrigerant-containing equipment in the covered RACHP subsectors. EPA is establishing this requirement in response to, and based on consideration of, comments[88] seeking assessment and data associated with reclaim use and availability. EPA is establishing a discrete reporting requirement for these entities to provide this information to EPA, so that EPA can further evaluate the availability of reclaimed HFCs intended for servicing and/or repair of appliances in these subsectors. The reporting requirement will require two annual reports (*i.e.*, one report in each of two years) to be submitted to the Agency, which includes information on the reclaimed HFC refrigerants sold or distributed to equipment owners and operators. Each annual report must be submitted by February 14 of the year following the reporting period and include information on the amounts and types of reclaimed HFCs intended for servicing and/or repair of equipment

[88] EPA received multiple comments, available in the docket of this rulemaking, related to taking a data driven approach to establish requirements for servicing and/or repairing refrigerant-containing equipment with reclaimed HFC refrigerants. Examples include EPA-HQ-OAR-2022-0606-0109, EPA-HQ-OAR-2022-0606-0121, and EPA-HQ-OAR-2022-0606-0147, among others.

and sold in the covered subsectors over the preceding calendar year. The first report is due on February 14, 2027, and covers activity from January 1, 2026, to December 31, 2026; the second report is due on February 14, 2028, and covers activity from January 1, 2027, to December 31, 2027. The Agency notes that these compliance dates coordinate with the labeling requirements being established in this rulemaking, such that refrigerant distributors would know which containers contain refrigerants with reclaimed HFCs. EPA intends to use this information to further evaluate the ability to comply with the requirements to use reclaimed HFCs in servicing and/or repair of appliances in these subsectors as established in this rulemaking. Further, the two-time reporting will allow EPA to assess the one-year trend in availability of reclaimed HFCs for use in the servicing and repair of refrigerant-containing equipment in the covered subsectors.

EPA notes that the reporting requirements here contain certain data elements that are similar to data elements that were originally proposed as a part of the container tracking provisions. As noted, the Agency is not finalizing those provisions in this action; however, the public was aware of EPA's interest in information on these topics through the proposal to include similar data elements in those other provisions. As commenters noted, and EPA agrees, there is value to collecting such data as it pertains to provisions that are being finalized in this rulemaking, notably, the requirements for servicing and/or repair of certain refrigerant-containing equipment with reclaimed HFCs. Thus, these reporting requirements are being established as requirements that are separate and distinct from the proposed tracking system requirements, although they include a limited number of data elements that are similar to some included in the proposed tracking system requirements. For example, these reporting requirements are different from the proposed tracking system requirements because they are being established to occur only twice and do not require data elements be reported at an individual container level.

Comment: Several commenters expressed broad support for EPA's proposed requirements for the recovery and reclamation of HFC refrigerant. Some commenters stated, consistent with the preamble to the proposal, that reclamation can bolster the current HFC supply, support a smooth transition to HFC substitutes, minimize disruption of the current capital stock of equipment, avoid supply shortages of virgin refrigerants, and helps to finance refrigerant recovery. Two commenters stated that because the proposed use requirements apply only to HFCs and not their substitutes, EPA's approach could encourage certain users to transition away from HFCs altogether into lower-GWP substitutes. One commenter suggested that increasing HFC reclamation benefits the climate, economy, and all users of cooling equipment and supports the availability of refrigerants for increasing demand for refrigerants in heat pumps for building decarbonization. The commenter further agreed that as proposed, the rule will help insulate the industry, and consumers, against price spikes that could affect the servicing of existing systems using HFCs. Another commenter stated that the provisions would send a strong market signal in favor of increased reclamation and lead to a reduction of HFC emissions and venting. Another commenter stated that sufficient reclaim volume may help reduce demand for new, virgin fluorocarbon production and consumption, which is more emissive than the reclamation process, and that the implementation of the subsection (h) rule can be a transformative force, particularly in addressing low rates of HFC reclamation.

One commenter generally supported reclaimed refrigerant mandates to drive recovery and stimulate investment, but requested that the final requirements be sensitive to market conditions in terms of current and projected refrigerant supply, production, and consumption.

The commenter stated that they did not support claims that reclaim mandates are not feasible because of insufficient material to meet demand or because market data for a given year takes time to accumulate and analyze. Another commenter supported regulations to increase the use of reclaim in the market, specifically through the incentivization of recovery and/or improvement of EPA's ability to enforce recovery. Another commenter also claimed that reclaimers have made significant progress investing in and installing technology to reclaim complex HFCs including fractional distillation to expand reclamation capacity.

Response: EPA acknowledges these supportive comments. The Agency agrees that the volume of reclaimed HFC refrigerants will grow significantly in the coming years particularly as the production and consumption of virgin HFCs decreases consistent with the phasedown provisions under the AIM Act. EPA anticipates this increased volume will support compliance with the requirements related to use of reclaimed refrigerants finalized in this action and addresses other comments related to supply of reclaimed HFCs in more detail in another response in this section. However, as described earlier in this section, EPA is establishing a discrete reporting requirement for data on the availability of reclaimed HFCs used in the servicing and/or repair of refrigerant-containing equipment in the covered RACHP subsectors and EPA may evaluate the requirements established in this rulemaking after assessing the reported data.

EPA responds to comments stating that these provisions may result in some equipment owners or operators switching to a refrigerant that is a substitute for an HFC by noting that entities may choose to transition to a different refrigerant for a number of reasons. For example, some equipment owners or operators may choose to transition on a decision based on energy efficiency. However, EPA is establishing reclamation requirements for servicing and/or repair of refrigerant-containing equipment in certain RACHP subsectors to promote reclamation of HFCs, consistent with the purpose identified in subsection (h)(1) of the Act of maximizing reclamation of HFCs. The Agency is not establishing these provisions as a means to promote transitions to substitutes for HFCs. While EPA did not primarily focus on this provision as a way to minimize emissions of HFCs from refrigerant-containing equipment, the Agency views other provisions finalized this rule as having that effect (*e.g.*, leak repair requirements as discussed in section IV.C). The Agency acknowledges these comments related to supply and availability of reclaimed HFCs as well as the availability of advanced reclamation technologies for efficient reprocessing and complex separations. Many commenters provided support that the supply of reclaimed HFC refrigerants would be adequate to achieve the provisions in this rulemaking, while other commenters noted concerns on supply. Further, commenters provided information on the availability and current use of these technologies to support the requirements of this rulemaking. EPA agrees with commenters that related to there being adequate supply of reclaimed HFC refrigerants to support the provisions in this rulemaking. Comments related to supply of reclaimed HFCs are discussed in additional detail in other responses later in this section and in section IV.E.1.

Comment: Several commenters supported reclaim requirements for servicing existing equipment. One commenter stated that all HFC refrigerants used in the servicing of equipment should be applicable to the proposal. One commenter generally supported reclaim requirements for the sectors specified. The commenter recommended extending servicing requirements to additional subsectors as adequate reclaimed HFC supplied become available. Another commenter supported the role of recovery and reclamation of refrigerants particularly as the supply of virgin HFCs is reduced.

Some commenters expressed support for the use of reclaimed refrigerants in existing equipment and urged EPA to maximize the use of reclaimed refrigerants in the market. One commenter claimed that until the transition to near-zero GWP refrigerants is complete, the use of reclaimed refrigerant will lessen the impact of continued use of mid-range GWP refrigerants and will help avoid stranding existing higher-GWP equipment that may be well within their useful life. Another commenter stated that a reclaim mandate for servicing of existing equipment would be reasonable as refrigerants supplied to service equipment are distributed through many channels and would not conflict with current business models. Another commenter requested that reclaimed refrigerants be mandatory only in servicing applications and states that the recovery of high-GWP refrigerants currently in use can be promoted more effectively, leading to a significant contribution towards mitigating global warming.

Another commenter generally supported most aspects of the proposed rule and stated that successful carbon reduction initiatives require cooperation among chemical manufacturers, wholesale distributors, technicians, EPA-certified reclaimers, and government agencies. The commenter appreciated EPA's transparent, collaborative, and market-neutral approach to the HFC allocation, technology transitions, and refrigerant management rulemakings.

Response: EPA acknowledges these comments in support of the provisions related to the use of reclaimed HFCs in the servicing and/or repair of equipment in certain RACHP subsectors. In the Agency's view, based in part on its experience with ODS-containing equipment, that reclaimed HFCs will play an increasingly key role to support existing equipment as virgin materials become scarce; several of these comments provide additional support for that view. As described in more detail in responses later in this section, EPA is establishing requirements for the use of reclaimed HFCs in the servicing and/or repair of equipment in three RACHP subsectors: supermarket systems, refrigerated transport, and automatic commercial icemakers. EPA agrees that these requirements to use reclaimed HFCs in servicing certain equipment is reasonable and will not be disruptive, as reclaimed refrigerants are available for these sectors and used to a degree already. EPA also is reiterating that we are not at this time establishing requirements for the use of reclaimed HFCs in the initial fill of refrigerant-containing equipment in any RACHP subsectors and is maintaining the focus of this rulemaking on servicing and/or repair of equipment in the covered RACHP subsectors.

EPA acknowledges comments regarding evaluating for additional applicability of the reclaim use requirements for servicing and/or repair of equipment in other RACHP subsectors. The Agency discusses the consideration of additional subsectors in another response in this section.

Comment: One commenter stated that reclaimed refrigerant has played a crucial role in maintaining chillers for decades, starting with CFCs. The commenter also noted that reclaimed HCFC-22 played a critical role in the gaps of supply after EPA, in compliance with the Montreal Protocol, accelerated the HCFC phaseout schedule and banned HCFC-22 for new equipment when there were brief periods of concerns about shortages for servicing.

Response: EPA acknowledges this comment and agrees that reclaimed refrigerants have played an important role in servicing ODS equipment leading up to and since the production and consumption of those ODS have been phased out; as noted in a prior response in this section the Agency's experience with ODS-containing equipment informs its view that reclaimed HFCs will play an increasingly key role to support existing equipment as virgin materials are limited. While this rulemaking does not include required use of reclaimed HFCs for chillers, EPA notes the commenter's example of the importance of reclaimed refrigerants to meet servicing demand where virgin refrigerants have become scarce.

Comment: Some commenters opposed the proposed requirements for the use of recovered and reclaimed HFCs for certain RACHP subsectors for servicing of existing equipment. The commenters argued that the proposal is creating consternation and uncertainty for their supermarket customers who have already been converting their systems to low-GWP refrigerants as quickly as possible. The commenters also argued that the HFC phasedown and 2023 Technology Transitions Rule will create demand for reclaimed refrigerants and EPA does not need to impose mandates to accomplish this. The commenters strongly encouraged EPA to withdraw any mandates on the use of reclaimed refrigerant and allow market dynamics to create an increased demand for reclaimed refrigerant without the added burden of a compliance risk. A few additional commenters expressed opposition to mandating the use of reclaimed HFCs in the specific refrigeration sectors, arguing it is unnecessary market manipulation. Some of these commenters added that the best time for switching may not be the same across all sectors and supported allowing market forces to drive the transition to reclaimed HFCs. The commenters claimed that regulations may distort key market features and negatively impact consumers. Another commenter suggested that EPA delete requirements for use of reclaimed refrigerants from the rule.

One commenter suggested that the phasedown schedule, most imminently the 2024 reduction, will significantly reduce the supply of regulated substances. With the reduction in available allowances to produce or import virgin regulated substances, "the supply of higher-GWP refrigerants will naturally be reduced for there to be enough allocation to satisfy the increasing demand for lower-GWP refrigerants." The commenter noted that the 2023

Technology Transitions Rule by design, will increase the demand for lower-GWP refrigerants exponentially each year due to new appliance GWP limits and the resulting dynamic of these requirements will lead to an increase in the demand for reclaimed HFCs, especially to service the installed base of higher-GWP refrigerant containing appliances. The commenter also stated that there is no evidence that the requirement to use reclaimed HFCs will lead to greater reclamation and the Agency did not show how this aspect of the rule would reduce releases of refrigerant. Further, the commenter stated there is no need for regulation to create demand for reclaimed refrigerant. For these reasons, the commenter stated that EPA's proposal to require the use of reclaimed refrigerants in servicing of certain equipment is unneeded.

Response: EPA acknowledges the comments and concerns described. EPA understands that the supermarket industry, like many industries, has been transitioning to lower-GWP refrigerants over time and will continue to do so consistent with the GWP limits and compliance dates in the 2023 Technology Transitions Rule. EPA acknowledges the concerns raised by some entities within the supermarket industry regarding the available supply of reclaimed refrigerants that will also be compliant with the 2023 Technology Transitions Rule's GWP threshold for new supermarket systems. EPA notes that it is not establishing requirements for the use of reclaimed HFCs for initial fill for certain types of equipment including. Therefore, the Agency is not responding to comments on initial charge.

In prior responses in this section, EPA notes the importance of reclaimed HFC refrigerant to support the continued operations of existing equipment, including certain older supermarket systems. The Agency agrees that existing market dynamics may incentivize the use of reclaimed refrigerants over time, but disagrees with the conclusion that those possible incentives mean this requirement is unneeded. Congress put particular weight on reclamation in subsection (h) of the

AIM Act, directing EPA in subsection (h)(1) to promulgate certain regulations, where appropriate, for purposes including maximizing reclaiming. Subsection (h)(2)(A) of the Act further provides that the EPA Administrator "shall consider the use of authority available under this section to increase opportunities for the reclaiming of regulated substances used as refrigerants." This requirement is consistent with both of these provisions. Moreover, even assuming that market dynamics or implementation of other programs lead to some additional reclamation and use of reclaimed refrigerant over time, the commenters do not provide any reason to think that those factors alone would "maximize" reclamation. It is the Agency's view that the regulatory programs established under the AIM Act work in conjunction with each other and implementation of each is necessary as we phase down HFCs, and the reclaim requirements established in this action will help increase reclamation and support additional recovery of HFC refrigerants. To the extent that the comments intend to suggest that EPA should provide a particular type or amount of information related to each regulatory provision's effects on increasing reclamation or reducing releases, EPA disagrees. As explained earlier in this preamble, as EPA interprets the statutory text in subsection (h)(1), the suite of regulations established under subsection (h)(1) of the Act, taken together, are focused on serving the three purposes identified in subsection (h)(1), but individual regulatory provisions under subsection (h)(1) need not each connect to all three purposes. This interpretation is integral to establishing an effective regulatory program, as some regulatory provisions that might be considered under (h)(1) may be highly efficacious at addressing one of the regulatory purposes but not address the other two, or alternatively, may be important to support the functioning of the regulatory program as a whole, but not be focused on any of the identified purposes.

The Agency does not agree with the comments that requiring the use of reclaimed refrigerant by sector is market manipulation. Rather, these requirements are a reasonable approach to implementing aspects of subsection (h)(1). Among other things, subsection (h)(1) of the AIM Act directs the Agency to establish regulations to control, where appropriate, practices, processes, or activities regarding the servicing or repair of equipment that involves a regulated substance or the reclaiming of a regulated substance used as a refrigerant. EPA interprets subsection (h)(1) to authorize this type of provision to require reclaimed HFCs in the servicing and/or repair of certain equipment in certain subsectors. The requirements in this rulemaking to control the servicing and/or repair of certain refrigerant-containing equipment are within this authority and support the purpose of maximizing reclaim of HFCs. Further, EPA's decision to apply these requirements only to refrigerant-containing equipment in particular RACHP subsectors is based on consideration of where such controls are "appropriate," as the availability of reclaimed HFCs may not be prepared to support such requirements for all existing RACHP equipment by the compliance date.

Comment: EPA received many comments regarding the availability of the supply of reclaimed refrigerant to meet the required uses of reclaimed HFC refrigerant as proposed. A few commenters claimed that the reclaim rate will not increase to meet demand and that EPA has not provided sufficient data to support the availability of necessary reclaim material for the regulated sectors. The commenters stated that even if HFC reclamation continued to grow at 38 percent every year supply would barely provide half of the quantity needed in 2028. One commenter stated that not enough recovery machines sold in the United States to support EPA reclaim mandate, thus leading to insufficient refrigerant recovery and reclamation. The commenter claimed that this resulting refrigerant shortfall will drive up costs. Another commenter noted that the inadequate supply of reclaimed gas meant that the reclaim mandates were consequently unlikely to be practical, achievable, or enforceable. Another commenter was skeptical that enough reclaimed refrigerant will be available in the market by 2028 and claimed that the rulemaking record does not support that a sufficient quantity will be available. One commenter stated that only 4 percent of 2022 demand for R-410A was reclaimed in 2022. The commenter further stated that new systems need to be installed in order to realize the transition to lower-GWP refrigerants and that there will be a lack of recovered refrigerant from new technologies using lower-GWP refrigerants until equipment approaches retirement. The commenter also claimed that including equipment meeting Technology Transitions GWP limits would complicate the reclaim process. The commenter claimed that this approach is consistent with the statutory design of the AIM Act by allowing the phasedown to move at its prescribed pace while accommodating sector and subsector-specific restrictions while avoiding potential disruptive market effects. Another commenter stated that current low recovery and reclamation volumes and a lack of market readiness do not support establishing reclaim mandates but, if EPA proceeds, such requirements should require use equal to reasonable market supply projections. Another commenter stated the challenge of obtaining a sufficient amount of recovered refrigerant available to reclaim and stated that any provisions to minimize releases should be balanced such that adequate supply of refrigerant is available.

A couple of other commenters stated that EPA has not evaluated reclaim availability on a sector-specific basis, instead assuming that the availability for each reclaimed HFC will increase consistently across all HFC blends. The commenters stated that EPA needs to look at HFC blends in each sector because certain blends are hard to recover and are end-use specific. The commenters stated that R-404A and R-507 are two examples of refrigerants that are difficult and expensive to reclaim and that many reclaimers cannot reclaim these blends or would choose not to, leading to insufficient supply and refrigeration problems.

Another commenter expressed concerns regarding the future market availability and price of certified reclaim like that of R-410A because there are no “drop in” substitutes to replace it. The commenter stated that this is very different from EPA’s most recent 2010 refrigerant transition in the stationary AC and heat pump market where there were alternatives for HCFC-22 thus industry had options which they do not have in this transition. The commenter noted this could create unforeseen shortages unless EPA takes actions to ensure reclaim mandates are based on actual data and are focused on the service market. The commenter expressed concerns that EPA's future projected reclaim quantities will not be sufficient to meet actual market demand for both initial charge as well as aftermarket/service demand thus encouraged EPA to focus on the service/aftermarket and remove the initial charge mandates from the proposed rule.

Another commenter stated that the challenge of providing sufficient reclaimed HFCs to maintain HVACR systems is not the reclamation capacity of reclaimers but rather obtaining sufficient recovered HFCs. The commenter argued that regulations increasing demand for HFCs or adding costs to reclamation would exacerbate the situation. The commenter pointed to the fact that most manufacturers have typically mandated virgin refrigerants in new applications and that the reclaim mandate in the proposed rule upends this. The commenter noted that some in the industry anticipate that HFC availability will drop significantly following the 2024 phasedown step of a 30 percent reduction, motivating the use of less refrigerants. The commenter stated that only one percent of the expected 2028 HFC market requirements are currently recovered and that it is not clear how this will satisfy the 85 percent requirement for new system charging and that consumers will still demand that systems function even if there is insufficient supply. The commenter acknowledged that moving to alternate refrigerants will take some pressure off the HFC demand but stated that very little new A2L product is entering the market. The commenter stated ramping up significant transition by the end of 2024 looks to be very challenging and questioned whether there will be enough relief in the HFC supply by 2028.

One commenter stated that contrary to EPA's suggestion in the preamble to the proposed rule that HFC reclamation is increasing, the reclamation sector is experiencing significant structural, market, and regulatory challenges that have limited refrigerant reclamation's growth in the United States over the past decade. The commenter argued that despite expectations of an increase in reclaim volumes, the overall data indicates a decrease, with 2018 yielding 18.1 million pounds per year, and even with the slight rise in HFCs in 2022, the total pounds amount to 15.4 million pounds for the same year. However, the commenter also stated that this rule, once finalized and implemented, could catalyze a substantial shift, resulting in the HFC reclaim market growing tenfold by 2032. The commenter stated that the reclamation volumes that EPA foresees are highly attainable by 2028, due to the effectiveness of the AIM Act hinging not on the capabilities of U.S. reclaimers, but on overcoming structural barriers in refrigerant pricing to establish a genuine circular economy for refrigerants, where reclamation stands as the low-cost solution

A few commenters suggested that EPA formulate alternatives to the proposed reclaim provisions and align with more realistic expectations and assumptions. Both commenters stressed the following two principles: basing reclaim mandates on relevant data to ensure practicality and phasing in reclaim mandates on a gradual basis. These commenters recommended that EPA establish a process to review data on the projected availability of reclaimed refrigerant and adjust requirements for the following year as needed. One commenter recommended that EPA use a data driven approach to set reclaim mandate requirements using a lagging model where future mandate amounts depend on actual reclaim production amount. The commenter stated that such a lagging model would allow EPA to mandate higher reclaim if recovery rates increase but also avoid market disruption. Two commenters recommended that EPA actively engage with industry stakeholders to gather comprehensive data on reclaim infrastructure capacity, available refrigerant types and quantities, and market demand across different sectors to provide a solid foundation for a more effective and efficient regulatory framework. One commenter recommended that EPA revisit reclaimed HFC data and adjust requirements based on real-world feasibility. Another commenter stated that the Agency may consider other mechanisms within its authority to increase reclamation. Another commenter urged EPA to conduct further analysis on a refrigerant-by-refrigerant basis to ensure there will be enough used refrigerant available for reclaimers to process to support the volume of reclaim needed by January 1, 2028.

Another commenter suggested that EPA may wish to consider collecting information on the total amount of refrigerant recovered compared to the total amount purchased by various entities as well as the percentage of the total amount purchased that is used for installation of new equipment compared to the total amount used to top up leaks. The commenter suggested that EPA may wish to interview CARB and OEMs as to the successes and challenges associated the R4 Program to learn from the largest experiment of its kind in the United States, which appears to have resulted in an increase in R-410A reclaim by as much as approximately 500 tonnes from 2021 to 2022. The commenter noted that CARB allowed for an alternate compliance pathway of “Early Action” to transition to a low-GWP refrigerant prior to 2025, which means that not all OEMs were required to participate, which may be reflected in the slight increase in reclaimed refrigerant reported to EPA.

Response: EPA acknowledges these comments related to the supply of reclaimed HFCs to support the reclaim use requirements established in this rulemaking. EPA understands the need for increasing recovery of refrigerants and assuring that these refrigerants are provided to reclaimers for subsequent reclamation. The Agency took advanced comments on technician certification and in a future proposal could consider the relationship between technician certification and recovery. The Agency has taken into consideration in this rule requirements for reclaimed HFC use and expects these regulations will provide market signals that will lead to increased recovered HFC refrigerants becoming available for reclamation, and that will support reclaimers increasing the amount of reclaimed refrigerants available to supply the increased demand. EPA also acknowledges comments describing a need to evaluate reclaim use requirements on data. In this rulemaking, EPA is making modifications to the proposed approach and finalizing provisions based on additional consideration of these challenges and needs, as described in the following paragraphs.

First, the Agency is not at this time establishing requirements for the use of reclaimed HFCs in the initial fill of refrigerant-containing equipment in certain RACHP subsectors. The Agency understands concerns related to reclaiming newer refrigerant blends that are more recently being used in equipment and comply with the restrictions established in the 2023 Technology Transitions Rule. EPA understands that a significant portion of recovered and reclaimed refrigerants are sourced when refrigerant is recovered at a piece of equipment's EOL, which for newer refrigerant blends may be a number of years from now. This timing could limit the availability of reclaimed refrigerants to meet requirements to use reclaimed refrigerants for initial fill of new equipment within the proposed time frame Second, EPA is narrowing the scope of covered RACHP subsectors that will be required to use reclaimed HFC refrigerants for the servicing and/or repair of equipment within those subsectors. EPA is finalizing these requirements for supermarket systems, refrigerated transport, and automatic commercial icemakers. EPA is not finalizing these provisions for stand-alone retail food refrigeration equipment, in part given that in many cases this equipment is hermetically sealed and less likely to have field repairs in the same way as field-charged equipment. Thus, EPA is focusing these requirements in the final rule on servicing and/or repair to narrow the provisions for reclaim requirements on existing equipment that are using HFC refrigerants that have an available installed stock and are currently being reclaimed. The types of refrigerant-containing equipment affected by these provisions are those that are currently existing and in-use, thus the installed stock of refrigerants to continue to support the useful life of these types of refrigerant-containing equipment will be supported as older ones reach their EOL. The RIA addendum accompanying this rulemaking provides additional analysis of the existing stock of HFCs by type of refrigerant-containing equipment. By narrowing the rule in this way, resources can be focused on providing reclaimed HFCs for servicing and/or repair of existing refrigerant-containing equipment in certain RACHP subsectors, where there is a greater ability to obtain recovered refrigerants from equipment that is at its EOL.

Third, EPA is delaying the compliance date for these provisions by one year to January 1, 2029. This delay of the compliance date should enable reclaimers to increase their supply of reclaimed refrigerants to meet demand for servicing and or repair of equipment in the covered subsectors. EPA notes this date aligns with the next major phasedown step of production and consumption of virgin HFCs under the AIM Act, when reclaimed HFCs will play an even greater role in supporting the servicing and repair of existing equipment. Further, EPA is aware of examples from reclaimers that are actively building capacity of advanced separations technologies.[89] EPA acknowledges comments related to suggestions for phasing in these requirements; however, the Agency is not finalizing such a method for these requirements, for the reasons discussed in another comment and response in this section.

Finally, EPA is establishing a discrete reporting requirement to better understand the sale, distribution, and availability of reclaimed HFCs in the subsectors covered in this rulemaking. As described in this section, EPA is requiring reporting by reclaimers and distributors that contain information on the volumes of reclaimed HFCs sold and intended for servicing and/or repair of equipment in the covered subsectors. EPA is establishing a two-time reporting requirement to gather this information and better understand the landscape for reclaimed HFC availability for these subsectors in 2026 and 2027 (reports must be submitted by February 14, 2027, and February 14, 2028, respectively), leading up to the compliance date of January 1, 2029. EPA notes that the Agency will review this information and may consider proposing changes to the reclaim use requirements, if warranted.

EPA acknowledges the comments related to assessing particular blends and subsectors as related to reclaimed HFC refrigerant availability. EPA considered this in the draft report "Analysis of the U.S. Hydrofluorocarbon Reclamation Market: Stakeholders, Drivers, and Practices," available in the docket for the proposed rule, and evaluated the anticipated demand of HFCs in the covered subsectors. Related to R-404A and R-507, the Agency understands the uses of these particular blends in each of the covered subsectors of this rulemaking. Even if the commenters were correct about the current costs and difficulties sourcing these refrigerants

[89] A-Gas (2023). A-Gas Breaks Ground on Additional Market-Leading Refrigerant Separation Technology. Available at: *https://www.agas.com/us/news-insights/a-gas-breaks-ground-on-additional-market-leading-refrigerant-separation-technology*.

today, EPA notes that these blends are currently being reclaimed, and the Agency anticipates this rulemaking to provide market signals to reclaimers to increase reclamation of these blends and secure additional recovered materials. Similarly, EPA anticipates those recovering HFCs from equipment will be aware of reclaimers' increased need for such materials and will increasingly develop arrangements to provide recovered HFCs to reclaimers. R-404A in particular has had a steady volume of reclamation between approximately 400,000 and 500,000 pounds each year from 2017 to 2022.[90] While specific data on R-507 reclamation are not published, reclamation volumes of R-507, as reported to EPA, have been steady between approximately 40,000 and 113,000 pounds each year, with an increasing trend. EPA reiterates that the Agency is only requiring the use of reclaimed refrigerant for servicing a limited number of subsectors. The RIA addendum estimates that approximately 12,148 metric tons (26,782,600 pounds) of reclaimed HFCs will be needed to meet this demand in 2029 and that this amount will decline in future years due to the transitions to lower-GWP refrigerants under the 2023 Technology Transitions rule. Further, we note that the amount of reclaimed HFCs increased over 40 percent from 2021 to 2022.[91] At that rate of increase, the amount of reclaimed refrigerants would be over 82 million pounds in 2029 and exceed that estimate of demand by over 200 percent.

Regarding the commenter's supposition that allowance use for virgin HFCs could potentially shift to other subsectors as reclaim use requirements come into effect for the subsectors covered in this rulemaking, EPA responds that as the phasedown continues, EPA anticipates market shifts that could include changes in the production and consumption of certain

[90] Available at: *https://www.epa.gov/section608/summary-refrigerant-reclamation-trends*.
[91] EPA Refrigerant Reclamation Summary 2000-2022. Available at: *https://www.epa.gov/system/files/documents/2023-12/2022_reclamation_table.pdf*

HFCs and changes in the use patterns with reclaimed HFCs replacing virgin HFCs. EPA further notes that under the phasedown schedule established in subsection (e)(2)(C) of the Act, in the last step of the phasedown HFC production and consumption allowances equal to 15 percent of the respective baselines will continue to be available indefinitely. The Agency assumes difficult to transition and/or applications requiring higher purity HFCs will continue to require virgin HFCs into the future. While the Agency acknowledges that there will be shifting business practices given the HFC phasedown, the 2023 Technology Transitions rule, and this final rule that will increase the reliance on reclaimed HFCs especially for servicing RACHP and fire suppression equipment, there are business practices including patents and licensing arrangements that could affect the ability of certain reclaimers to supply certain customers with reclaimed HFCs. The Agency anticipates that as patents expire and licensing arrangements expand, these limitations will lessen. EPA reiterates that the reclaim use requirements have been narrowed to servicing and/or repair in three RACHP subsectors. Further, the compliance date for these requirements is January 1, 2029, which should give industry sufficient time to adjust current business practices.

EPA acknowledges the concerns of the commenters regarding challenges facing the reclamation industry and the Agency responds that several of the provisions established in this rulemaking are designed to support increased reclamation. These provisions focus specifically on the maximizing of reclaiming HFCs, consistent with one of the purposes identified in subsection (h)(1) of in the AIM Act. Per reported data for reclaimed refrigerants, in 2018, total reclaimed refrigerant (ODS and HFCs) was 14.7 million pounds and in 2022, total reclaimed refrigerant was 14.2 million pounds.[92] The commenter is correct that the total amount was reduced, considering both ODS and HFCs together. However, as noted, this rulemaking is focused on increasing reclamation of regulated substances (*i.e.*, HFCs), and HFC reclamation increased from 5.25 million pounds in 2018 to 7.6 million pounds in 2022, an increase of over 40 percent. EPA anticipates this trend to increase related to the provisions established in this rulemaking as well as the overall phasedown and increasingly limited supply of virgin HFCs.

EPA acknowledges the comment on collecting information on amount of refrigerant recovered. EPA recognizes the important role technicians play in recovering refrigerant destine for reclamation and that it may be useful to have such information collected; however, the Agency did not propose and is not finalizing recordkeeping or reporting requirements for certified technicians to collect information on the total refrigerants they recover in this rulemaking. However, the Agency notes that in a future rule where the role of technician certification programs are considered, the Agency may consider recordkeeping and reporting for technicians on the amount of refrigerant recovered.

EPA notes that under current reporting for certified reclaimers per 40 CFR 82.164, reclaimers are required to report on the annual totals of refrigerants they receive. EPA notes the value of reporting on a more granular level, however. The Agency also notes that in proposing these provisions, we reviewed information on the R4 Program, including a review of the state agency's statement of reasons related to establishing such a program. EPA found this is a useful source of information. The Agency is not establishing an early action option for compliance at this time. As noted previously in this response, EPA is establishing discrete reporting

[92] Id 86.

requirements to better understand the availability of reclaimed refrigerants in the covered subsectors prior to the compliance date for these requirements.

Comment: One commenter noted that the reclaim industry has already reached a large scale of reclaimable refrigerant when there was no Congressional mandate to reclaim this product and the public was generally unaware of the negative environmental effects associated with HFC refrigerant emissions. The commenter stated that EPA can meet its 100 percent reclaim usage goals through rapid scaling of recovery rates for HFC refrigerants under the AIM Act which has already given HFCs high economic value. The commenter suggested that the refrigerant in the installed base aftermarket and in equipment approaching their end-of-life will both coincide well with recovery opportunities. The commenter stated that that the servicing sector, specifically the contractors, is the only real material source for increasing the amount of reclaimed refrigerants, which if recovered more consistently will lead to the corresponding growth in reclamation necessary for an orderly transition under the AIM Act. The commenter also noted that mandating reclaim use in the servicing sector would encourage more recovery by contractors and that this approach incentivizes contractors to provide more recovered refrigerant to reclaimers to ensure access to reclaimed refrigerant to service consumers' needs.

Response: EPA acknowledges this comment. EPA agrees that scaling up HFC refrigerant recovery and reclamation will become increasingly important as HFCs are phased down and appreciates efforts that have already been taken, including those taken prior to the enactment of the AIM Act. EPA acknowledges the role of the technicians and contractors in the overall recovery of refrigerant, especially as equipment reaches its EOL. The Agency is aware of a range of programs, including those with incentives, that have been used by OEMs and reclaimers to support recovery of refrigerants.

Comment: One commenter stated that requiring reclaimed HFCs for servicing is largely untrialed in the United States and needs gradual testing and iteration. The commenter mentioned that California is currently in the first year of implementation of its R4 Program, which requires OEMs for residential AC and VRF systems to use specific calculated reclaim volumes in 2023 and 2024. The commenter noted that since the inaugural year of the program has not yet concluded, comprehensive data and conclusive findings regarding the program's efficacy and success are currently unavailable to the broader stakeholder community to inform the formulation of a national reclaim requirement rule.

Response: EPA disagrees that reliance on reclaimed refrigerants is in untrialed in the servicing sectors. As discussed elsewhere in this final rule, the Agency notes that since 2020, reclaimed HCFC-22 is the only viable option for servicing legacy HCFC-22 systems. Similarly, for the CFC systems, this has been the case since the 1990s. The Agency also notes the amount of reclaimed HFCs has been reported annually to EPA since 2017 and that the amount has been increasing. Reclaimers are selling reclaimed HFCs and competing with virgin HFCs in many markets particularly for servicing certain RACHP and fire suppression equipment. The Agency proposed and is finalizing a program that is markedly different from the R4 Program. Further, the Agency will be interested in any data California will be able to share; however, the Agency does not need that data to finalize a reclamation program under subsection (h).

Comment: Many commenters discussed the demand and supply of relevant refrigerated blends for servicing, especially R-410A. One commenter stated that EPA's mandate for reclaimed HFCs, when combined with the 2023 Technology Transitions Rule, will likely drive perverse commercial practices to meet this demand because companies will be incentivized by EPA's rules to take usable, reclaimed R-410A and separate out the HFC-32 from the HFC-125 in order to make reclaimed HFC-32. The commenter claimed that not only would this be counterproductive to meeting demand for reclaimed R-410A service gas for that equipment base, but it would also require unnecessary energy consumption from the distillation process. In addition, the commenter stated that the stranded HFC-125 ultimately would simply be re-blended with virgin HFC-32 to make R-410A to be sold into subsectors that are not subject to the reclaim mandate, creating a repetitive and unproductive loop.

Additionally, a commenter stated that separating individual HFC refrigerants from recovered refrigerant mixtures, such as R-410A, R-404A, and the R-407 series, is not necessary, particularly because the demand for such reclaimed refrigerant mixtures particularly for service will be high and would in fact be an environmental detriment due to the high energy consumption required for the separation process.

An additional commenter stated that the HFC market would be disrupted by the requirements described in the NPRM and noted that reclamation currently services at best less than nine percent of the expected 2028 demand. The commenter additionally stated that the proposed rule does not explain how the reclamation industry will achieve the necessary growth and that even achieving growth at a rate of 38 percent (i.e., the growth from 2021 to 2022) would not supply a sufficient quantity of reclaimed HFCs. The commenter claimed that the disconnect between supply and demand would be even wider than this because of highly mixed refrigerants which require advanced fractional distillation, technical expertise, and high capital costs. The commenter provided an example for HFC-32, estimating that HFC-32 reclamation in 2022 represented 2.4 percent of what will be needed in 2028. The commenter further claimed that, given that HFC-32 units will not be available to be reclaimed in significant quantity for 15-20 years, reclaimers may try to reclaim mildly flammable HFC-32 from R-410A. The commenter noted that R-410A is azeotropic and therefore requires significant energy to separate, requires investments in equipment due to HFC-32's mild flammability, and that there would only be a limited market for the HFC-125 that remained. The commenter concluded that there is therefore a mismatch between HFC-32 demand and supply of reclaimed material and that the weight of the reclaim requirement would fall on the HFC-32 producer. Another commenter noted that they currently use fractional distillation to separate HFC-32 from recovered refrigerant blends to ensure purity that meets or exceeds the AHRI 700 standard for the product. The commenter claimed that sustaining adequate HFC-32 supplies to 2029 and beyond is crucial to ensure equipment operation until the EOL because its GWP is below certain thresholds established in the 2023 Technology Transitions Rule.

Another commenter argued that EPA's reclaim requirements ignore how refrigerant is recovered. The commenter stated that refrigerant is recovered when equipment is replaced, retrofitted, or retried, and that given the long lag times between when new equipment is installed and when equipment is replaced or retired, the large increase in R-410A reclamation that occurred from 2021 to 2022 is due to R-410A equipment that was replaced or retired in 2010, and that a large annual increase in R-410A reclamation is not foreseeable based on existing data. The commenter claimed that EPA should model reclaim supply based on the installed base of refrigerants, estimated by yearly turnover and estimated recovery efficiency. The commenter modeled the R-410A installed base using AHRI shipment data for RACHP from 2008-2022, and provided an attachment with data to support its argument. The commenter used this data to argue that the growth in reclamation of R-410A in 2022 was expected, because there was an increase in new units using R-410A in 2010 compared to 2009. Furthermore, the commenter stated that it considered the equipment mix when factoring in future reclamation numbers of R-410A, as well as how refrigerant is recovered.

Another commenter mentioned that the maximum amount of annual "recoverable" and subsequently "reclaimable" R-410A in 2022 would be approximately 29,000 metric tons or 63 million pounds of R-410A and that the amount of reclaimed R-410A reported to EPA by the reclaimers in 2021 was 2.5 million pounds. The commenter stated it is abundantly clear that there is great scope for improving recovery and reclamation rates for HFCs that would 1) yield significant climate benefits resulting from preventing those GHGs from being emitted into the atmosphere and 2) reduce the need for supplies of virgin HFCs. The commenter further noted that some may argue that the small quantities of HFCs reclaimed today are evidence that the reclamation market will not be able to meet the demand for reclaimed HFCs under the proposed rule, but stated that the current HFC reclamation data reflects the absence of market drivers that will make reclaimed HFCs a valuable commodity. The commenter stated that the amount of R-410A reclaimed in 2022 is nearly 40 percent higher than the previous year and that this is a clear sign that the start of the HFC phasedown and the expectation of regulatory mandates for use of reclaimed HFCs can lead to dramatic, positive shifts in the industry. The commenter also stated that EPA may hear that scaling capacity for advanced fractional distillation reclamation will take time, and that splitting out component gases of azeotropic or near-azeotropic refrigerant blends tends to use more energy than reclaiming blends like R-410A back to their original form without separating out its components. The commenter noted that this may be true; but there is also good reason to encourage the development of a reclamation industry that is capable of splitting mixed gases.

The commenter mentioned that new refrigerants favored by most of the large OEMs are HFC-32 and blends using HFC-32 (*e.g.*, R-454B). The commenter stated that the main source of reclaimed HFC-32 will be recovered R-410A, which is the refrigerant currently used in most RACHP equipment, and that separating HFC-32 out from R-410A is feasible and, if recovery is maximized - as is the intent of the proposed rule - there will be a sufficient quantity of it available to meet the demand. The commenter estimated that there will need approximately 72 million pounds of recovered R-410A and that if recovery of R-410A from retiring equipment is maximized, an estimated 63 million pounds of R-410A would be recovered in 2022. However, the commenter noted that the amount of recoverable R-410A will grow, since the number of retiring systems grow just as the number of new systems do. The commenter estimated the amount of recoverable R-410A in 2028 will be approximately 70 to 74 million pounds, which will be sufficient for meeting the demand for reclaimed HFC-32 in 2028. The commenter noted that there might be challenges but ultimately, the data suggest that there is a tremendous untapped opportunity for upscaling HFC recovery and reclamation in the United States.

Another commenter stated 63 million pounds of recovered R-410A could yield 31.5 million pounds of reclaimed R-32 for use in the initial charge of new equipment using R-32 or other blends mainly composed of HFC-32 and HFOs. The commenter noted that the R-410A available from 2024-2027 would also supplement annual amounts recoverable from 2028 onwards.

Another commenter stated that EPA's existing data supports the availability of sufficient refrigerant in the aftermarket to meet service sector demand at 100 percent by 2028. The commenter suggested that the total amount of refrigerant available for recovery at EOL is likely in excess of 80 million pounds annually and that based on this estimate, the amount of refrigerant available for recovery via service is sufficient to meet the goals described in the proposed rule. However, the commenter suggested that it will be difficult for EPA to meet their reclaim goals without the consideration of an alternative construction of the reclaim mandate as a servicing mandate based on refrigerant types rather than sectors. The commenter noted that it would be impossible to meet EPA's goal without focusing on the recovery of R-410A, which is predominately used in small outdoor units.

Response: EPA acknowledges these comments and understands the competing interests for reclaiming particular HFC blends as compared to separating out and reclaiming particular components to be used either neat or in other blends. EPA understands that the example of HFC-32 as a component of R-410A is one of the more common scenarios in practice. EPA notes, as described in other responses, that we are finalizing requirements for reclaim use in the servicing and/or repair for equipment in certain RACHP subsectors. EPA is not establishing requirements for initial charge at this time, where the Agency anticipates a majority of HFC-32, blends that include HFC-32, and other blends will be used in the coming years.

EPA acknowledges comments about supply of reclaimed HFCs and those related to driving supply of reclaimed HFCs through the requirements established in this rulemaking. The Agency also notes comments providing specific detail on potential availability of reclaimed refrigerants, and in particular on HFC-32 as sourced from recovered R-410A, and the Agency understands that there is room for improvement in the increase of refrigerant recovery to supply to reclaimers. EPA notes that R-410A comprised about 39.2 percent of the existing installed refrigerant stock by mass in 2022, while other blends such as R-404A, R-407C, and R-507 also make up a significant portion of the 2022 installed refrigerant stock. Reclamation data, as reported to EPA, show that R-410A is also currently the most commonly reclaimed HFC refrigerant in the United Stated by weight. Annual reclamation data reported to EPA indicates that the annual supply of reclaimed R-410A has increased from about 2,100,000 pounds in 2017 to over 3,591,000 in 2022.[93] The Agency provides additional detail on similar comments related to supply of reclaimed refrigerants and provides a response earlier in this section. The mix of refrigerants will change over time given the overall phasedown of HFCs, the 2023 Technology Transitions rule, business decisions, and other factors including demand for more energy efficient equipment. The reclaim requirements help to support the goal of subsection (h) of the AIM Act to maximize reclamation. EPA understands that it may be preferable at times for reclaimed R-410A and/or other reclaimed refrigerant blends not separated to their components EPA considers reclaiming and making available refrigerant blends to be one way to avoid retiring equipment early. However, EPA also acknowledges comments regarding increasingly available capabilities of reclaimers to separate out components from refrigerants blends for individual reclamation or to be combined so as to increase the available supply of a different refrigerant blend. Over time, particularly as the refrigerants used in equipment changes, the Agency anticipates seeing movement in this direction. The Agency anticipates that demand will drive the reclaimers' decisions concerning reclaiming a blend or separating the blend for its components. EPA previously noted and agrees with comments that HFC-32 reclamation by separating from recovered blends is a current practice. The Agency further acknowledges for reclaimers to address safety considerations when handling HFC-32, and other mildly flammable and/or flammable refrigerants particularly if reclaimers choose to use separation technologies.

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[93] U.S Environmental Protection Agency Refrigerant Reclamation Summary 2000-2022, November, 2023. Available at: *https://www.epa.gov/section608/summary-refrigerant-reclamation-trends*.

Further, the Agency is establishing alternate RCRA standards for reclamation facilities related to handling flammable refrigerants, as described further in section IV.H of this rulemaking.

As noted, EPA is not establishing requirements for reclaimed HFCs in the initial fill of equipment in certain subsectors in this rulemaking. Therefore, subsectors that may be using HFC-32 or blends that contain HFC-32 could source the refrigerant for initial charge from either virgin or reclaimed supplies.

In the case that recovered R-410A is separated out to its components for their individual reclamation, the Agency disagrees that the HFC-125 would be stranded or only be used for reclaimed R-410A. EPA notes that HFC-125 is used in other HFC refrigerant blends besides R-410A. If HFC-32 reclamation is achieved through separation of recovered R-410A, the remaining HFC-125 could be used in these other blends, including R-404A, the R-407 series, or R-507, which are HFC blends the Agency anticipates will be used in the covered subsectors for reclaim use requirements for servicing/repairing equipment. HFC-125 is also a component of several newer refrigerant blends and could be used in the those blends as well.

EPA responds to comments on establishing provisions related to reclaim use requirements on a refrigerant basis rather than a subsector bases. The Agency notes that a subsector approach is preferable in this rulemaking as it avoids cases where there could be shortages of particular reclaimed HFCs or HFC refrigerant blends. The Agency has similarly looked at sectors and subsectors in other parts of this rule (*e.g.*, leak repair thresholds, ALDs) and in other AIM Act rules (*e.g.*, 2023 Technology Transitions rule). The Agency considers this approach, sectors and subsectors as a means of setting a level playing field for all participants in that affected sector or subsector.

Comment: Multiple commenters expressed support for phased-in reclamation requirements. One commenter expressed support for EPA's proposed requirements but acknowledged that the supply of reclaimed refrigerant will need to be scaled up quickly to meet the requirements by 2028. To facilitate this transition, the commenter suggested that EPA assist the industry by setting benchmarks and interim targets to ensure refrigerant recovery and reclamation will expand at the pace and scale needed to support the HFC phasedown. Another commenter strongly agreed with the principle behind requiring use of reclaimed and recycled HFCs and was optimistic about the pace of change in the recovery and reclamation industry. The commenter noted that the benefits of a graduated schedule would outweigh greater reporting requirements, but that the schedule should start sooner than 2028 and ramp up to 100 percent by 2028. The commenter stated that it would be important to boost reclaimed HFC availability before the 2029 HFC phasedown step to fulfill HFC demand. Another commenter proposed using reclaimed refrigerant in the servicing of equipment with the interim goals of 10 percent in 2026, 20 percent in 2027, and 35 percent in 2028 and on. Other commenters recommended a gradual phase-in of reclaim requirements based on data for the anticipated need of reclaim on a yearly basis.

Another commenter stated that a gradual step-up/phased-in approach is preferable to reach the 100 percent requirement goal in 2028 for reclaim usage under the proposed rule and it would allow sufficient reclaim supply growth to offset any shortage of available virgin HFCs and avoid market interruption which is needed for climate mitigation. The commenter stated they expect HFC reclamation to continue to increase and they urged EPA to adopt a step-up/phased-in approach to incentivize HFC recovery and reclamation between now and 2028. The commenter noted that a phased-in approach would incentivize the necessary changed behavior by all involved, especially the contractors who will need to recover more refrigerants over time to meet the demand for 100 percent reclaim in servicing and repair by 2028. The commenter noted that larger charged systems in the sectors already included in the proposed rule's service/repair mandate typically operate in confined spaces and have greater recovery rates at EOL and servicing when compared to smaller outdoor systems. The commenter stated that the types of refrigerant systems would include HFC-134a, R-404A, R-407A, R-407C, and R-507 systems, among others. The commenter suggested creating an initial reclaim mandate for servicing these systems starting in 2025 with a lower percentage of 25 percent and then building the requirement overtime to meet the 100 percent reclaim mandate in the proposed rule by 2028. The commenter expressed support for requiring the contractors to report that they are purchasing the proper amount of reclaimed refrigerant as defined in the proposed rule at a minimum on an annual basis will ensure compliance with this mandate. The commenter suggested that servicing of R-410A systems with reclaimed refrigerant might need a slightly longer ramp up period due to the behavioral change necessary by the contractors that service these R-410A systems. The commenter also suggested a 10 percent mandate for servicing these systems in 2025, increasing to 25 percent in 2026 and then continuing to increase to a 100 percent mandate by 2028.

Another commenter suggested a phased approach for reclaimed HFCs with initial targets based on data and industry feedback to incentivize reclaimed HFC use, which the commenter maintained would better align with the manufacturing process and supply chain realities of both equipment and reclaimed HFCs. The commenter encouraged EPA to revisit the reclaimed HFC data and adjust its approach based on real-world feasibility, considering existing supply chain disruptions and rising costs. The commenter recommended initially prioritizing the reclaim of high-GWP refrigerants and allow the market to adjust and around 2028 revisit the need for low-

GWP reclaim requirements based on market adoption, performance, technological advancements, and feasibility, starting with 2036 as a potential timeframe.

Two commenters noted that to the extent that EPA adopts a phased-in schedule for these mandates, it should be sector neutral (not sector-specific) and differentiated where necessary only on a product-by-product basis. Another commenter noted the reduced HFC supply under the AIM Act step-down and 2023 Technology Transitions Rule and suggested a phased approach that would be coordinated with the 2023 Technology Transitions Rule. The commenter also noted that only a small fraction was reclaimed in 2022 and that significant changes would be required to the entire supply chain to ensure sufficient recovery and reclaim quantities, which takes time.

One commenter noted they would not support a phased approach whereby EPA uses subsector percentages to work gradually towards 100 percent use of reclaimed HFCs in servicing and/or repair, given the administrative burdens necessary to track and verify compliance that are stated in the proposed rule.

Response: EPA is not establishing a phased-in approach for the requirements for reclaimed refrigerant use though the Agency encourages affected entities consider increased reliance on reclaimed HFCs ahead of the compliance date. As described above, EPA is narrowing these provisions and providing additional considerations. The Agency is limiting the requirements to only servicing and/or repair requirements for reclaimed refrigerant use in three subsectors with a delayed compliance date of January 1, 2029. The Agency understands the industry identified certain potential benefits to a phased-in approach with limited data to support this approach. The Agency is instead establishing a discrete reporting requirement to better gauge the sale, distribution, and availability of reclaimed HFC refrigerants in the subsectors required to use reclaimed HFCs for the servicing and/or repair of equipment. EPA intends to use this reported data to better assess transition to reclaimed HFC use in these subsectors and may consider revisiting the reclaim use provision timing prior to the compliance date, if warranted. While EPA intends to use this reporting to better understand the landscape of reclaimed HFCs in these subsectors, the Agency disagrees with commenters that suggested bumping out the timing beyond 2029 (*e.g.*, starting in 2036). Reclaimed HFC refrigerants are already being used and will increasingly play a significant role throughout the entire phasedown, not starting when the phasedown reaches its final step in 2036.

EPA agrees with the importance of increased recovery of refrigerants to support additional reclamation and potential need for changes related to this practice. The provisions in this rulemaking are expected to drive demand for additional recovery. Recovery and sending recovered refrigerants is likely to increase as the value of the recovered HFC refrigerants is more widely appreciated, HFC equipment reaches its EOL, and increases with reduced amount of virgin HFCs available as the HFC phasedown continues. EPA notes that many of the transitions to R-410A occurred in response to the 2010 HCFC phasedown step and associated restrictions on the use of HCFC-22 in new equipment. This means that a large amount of R-410A-containing equipment is approaching an expected EOL and this equipment will increasingly be a source of recoverable R-410A. Moreover, EPA disagrees that a required phased-in approach is necessary to cause a shift in behavioral changes and would be more effective than having the requirement begin at 100 percent reclaim use for servicing and/or repair in the covered subsectors.

EPA is establishing the reclaim use requirements on a subsector basis at this time. The Agency considered and is finalizing in this rulemaking requirements to use reclaimed refrigerants in a narrower list of subsectors after further evaluation and informed by comments on a range of factors. Additional discussion on covering more subsectors or taking a subsector approach are covered below. The Agency is not establishing requirements for reclaim use for initial fill of equipment in this rulemaking. EPA acknowledged in a previous response on the challenge of securing sufficient reclaimed refrigerants where the refrigerants have not been in the installed stock of equipment for sufficient time and may take a number of years for adequate reclaimed refrigerant to be available.

Comment: One commenter requested that EPA include a Force Majeure or hardship clause in the rule should the mandated amounts of certified reclaim not be available to regulated entities including OEMs because without such a clause, OEMs and other regulated entities could fall into non-compliance due to no fault of their own. The commenter also requested that EPA provide a mechanism whereby a regulated authority can appeal to EPA for relief should this situation occur. Another commenter stated that the proposed stipulation to utilize recycled or reclaimed substances poses a notable challenge as the future accessibility of these recycled or reclaimed materials remains entirely uncertain. The commenter argued that complying with the requirement might prove impractical and could result in significant operational delays or business closures. In lieu of these explicit requirements, the commenter strongly urged EPA to incorporate an alternative compliance approach, contingent upon the regulated entity maintaining documented evidence that the requisite recycled or reclaimed substances are unavailable, necessitating the use of virgin products. The commenter stated that this approach aims to offer flexibility in situations where compliance with the primary requirement is unfeasible due to material unavailability.

Response: EPA responds that the Agency is not establishing a Force Majeure or hardship clause as described by the commenter in this rulemaking. As noted in prior responses, EPA made changes from the proposed requirements that narrows the subsectors, delays the compliance date, and will use data to access the uptake of reclaimed HFCs ahead of the compliance date. EPA acknowledges comments related to unforeseen events which could affect operations at individual facilities that may impact contractual arrangements. However, the Agency does not agree with the need to provide any general regulatory exceptions to remove liability for unforeseeable and unavoidable catastrophes that interrupt the expected course of operations, though the Agency recognizes that there may be value in regulated entities including force majeure clauses in their contracts if the parties to the contract believe such a clause is appropriate.

Comment: Multiple commenters commented on whether lower-GWP refrigerants should be included in reclamation requirements for servicing. Some commenters supported excluding refrigerants with GWPs below the 2023 Technology Transitions thresholds from reclaim requirements. One commenter proposed that EPA should focus on refrigerants with GWPs that are above the GWP limits included in the 2023 Technology Transitions Rule for a final rule. The commenter noted that this change would also focus recovery and reclamation activity on the products with the highest GWP, where reclaim has the most environmental benefit per pound of gas recovered. Another commenter requested that EPA limit this reclaim servicing requirements to HFC refrigerants that are restricted by the 2023 Technology Transition Rule and not all HFCs regulated by the AIM Act. The commenter claimed that many low-GWP HFCs will not be introduced until January 1, 2025, so there will not be enough low-GWP HFCs recovered to generate enough reclaim to use in service for these sectors. Another commenter stated that reclaim mandates on low-GWP refrigerants do not make sense because these are not in widespread use. In contrast, a different commenter stated that EPA should not exempt low-GWP refrigerants from reclaim mandates and that having reclaim requirements for low GWP refrigerants will benefit the environment and create a more circular economy.

One commenter urged EPA to provide an exception for certain newer and commonly used low-GWP refrigerants such as R-448A, R-449A, and R-407A, stating that they are unlikely to be reclaimed in sufficient quantity to satisfy industry needs, as these substances have only recently started to be used in newly installed or retrofitted in commercial refrigeration systems. The commenter noted that these refrigerants are subject to patents held by their manufacturers, thus, not all reclaimers can legally formulate their blends, which will constrict supply. Another commenter suggested that the use of reclaimed refrigerant for service and repair of existing supermarket refrigeration appliances starting in 2028 should be limited to refrigerants with GWPs greater than 1500, if the reclaim mandate as of 2028 is pursued by EPA. Another commenter recommended that EPA prohibit the use of virgin refrigerant for servicing equipment in supermarket systems, cold storage warehouses, refrigerated transport, and automatic commercial icemakers with a GWP greater than 2,200 beginning January 1, 2029, and with a GWP greater than 1,400 beginning January 1, 2034.

Another commenter proposed that a refrigerant supplied for servicing in the applicable sectors that exceeds the established GWP thresholds set forth in the 2023 Technology Transitions Rule could be a specified percentage of reclaimed refrigerant, as determined by the Administrator on an annual and gradually increasing basis. The commenter suggested additional subsectors for consideration for servicing and/or repair requirements with reclaimed refrigerants. An additional commenter suggested EPA review market data and applicable percentages for servicing using reclaimed refrigerant annually via a notice and comment process. The commenter also suggested excluding from servicing requirements any equipment containing a refrigerant with a GWP below the applicable threshold established by the 2023 Technology Transitions Rule.

Another commenter stated that the reclaim use requirements cause concerns regarding the excessive burden being placed on the retail industry. The commenter expressed support for the need to incentivize reclaimed refrigerant as a way to balance the decreased supply of HFCs due to the decreased allocation of allowances, however, the commenter expected the focus of reclaim to be on the refrigerants which were not included as future options of the 2023 Technology Transitions Rule. The commenter also expected the focus of the proposed rule be on the need to service existing equipment throughout its natural lifetime.

One commenter added that heating, ventilation, and air conditioning (HVAC) equipment typically has a lifespan of around 10-15 years, and refrigerant recovery is very limited during this time, with recovery only possible during maintenance and repair work. Therefore, the commenter argued that after the transition to low-GWP refrigerants in 2025, these low-GWP refrigerants must not become the focus of recovery efforts until 2035 to 2040. The commenter stated that until then, the refrigerant contained in the already installed equipment will be the dominant part of the recovery work. The commenter stated that in the domestic and commercial HVAC sector, R-410A is the main target for recovery as there are no refrigerants below GWP 700 on the market. Therefore, the commenter suggested that it is substantially not feasible to obtain reclaimed refrigerants with a GWP of 700 or less as of 2028.

One commenter stated that there should be no exemptions for newer lower-GWP refrigerants (such as HFC-32, R-454A/B, R-448A, R-449A, R-450, R-456A, R-444A, or others). Another commenter argued that there is not enough HFO refrigerant available to support the service and new equipment market and recommended that reclaimed HFC and HCFC makes sense for 2028. The commenter requested further specificity regarding the statement requiring reclaimed refrigerant for repair and servicing.

Response: EPA acknowledges these comments concerning the GWP of refrigerants and basing the provisions for the required use of reclaimed HFCs with this consideration. Further, EPA understands commenters' suggested rationale of considering reclaimed refrigerant use requirements related to GWP limits established in the 2023 Technology Transitions Rule. As noted in previous responses in this section, EPA is not establishing requirements for the use of reclaimed HFC refrigerants in the initial fill of equipment in certain subsectors in this rulemaking. EPA understands that many newer refrigerants (*e.g.*, R-448A, R-449A, and R-407A) being used would be for the initial fill of new equipment in accordance with compliance with the restrictions established in the 2023 Technology Transitions Rule. However, EPA notes that based on reported data from certified reclaimers, newer refrigerants are currently being reclaimed albeit in smaller amounts but as previously noted, that will increase over time. Newer equipment is less likely to require repairs so the amount of newer refrigerants being reclaimed should comport with transition to those refrigerants. Also, as noted above, HFC blends can be separated into components and these components can be used to in other blends to the extent patents, licensing agreements, and other business relationships allow. As described above, EPA is establishing a reporting requirement that will further inform the provisions for reclaimed HFC refrigerant use in the covered RACHP subsectors. EPA will use the information in these reports to evaluate these provisions.

EPA is not establishing exclusions based on GWP for the reclaim use requirements in this rulemaking. The Agency disagrees with the suggested GWP level of 1,500 on which to base exclusions noting amongst of things, HFC-134a, which by volume currently is the second most reclaimed HFC refrigerant has a GWP of 1,430, thus supply is not tied to that GWP level. The Agency responds to comments on GWP considerations of 2,200 in 2029 and 1,400 in 2034. Similar to reasons discussed related to the GWP consideration of 1,500, these suggested cut-offs would exclude HFCs that have significant GWP levels. Regarding a GWP of 2,200, this would exclude HFC-134a, as noted above, and other HFC refrigerants that are currently being reclaimed, including R-407A, R-407C, and R-410A. A GWP-based exclusion of 2,200 would be inappropriate and could discourage the recovery and reclamation of these and other HFC refrigerants and refrigerant blends that will be important to have an available supply per the established requirements for using reclaimed HFC refrigerants in this rulemaking and as the phasedown progresses. Further, the GWP based exclusion at 1,400 would exclude other HFCs, such as R-448A and R-449A which are used in supermarket systems. A GWP cut-off of 1,400 may discourage efforts to recover and reclaim these refrigerants. The Agency responds to comments suggesting the GWP of 700 as the cut-off, which is the GWP threshold used for requirements established for certain sectors and subsectors in the 2023 Technology Transitions Rule. EPA notes differences in the statutory provisions in subsections (h) and (i) and maintains that in this final rule, EPA is promulgating requirements maximizing reclamation.

EPA acknowledges other comments related to not placing GWP-based limits on the reclaimed HFC refrigerant requirements for servicing and/or repair of certain refrigerant-containing equipment and the need to protect useful lifetime of the equipment. The Agency agrees and effectively designed provisions in this rule to avoid stranding equipment or forced early retirements. The Agency considered the long and successful use of reclaimed refrigerants as well as some of the longstanding concerns reclaimers have raised with market access and acceptability.

As noted in response to other comments, EPA is aware of both patents and certain business arrangements that pertain to certain newer refrigerants and notes the changes between proposal and final.

Comment: Another commenter requested that the reclaim mandate be limited to refrigerants with GWPs greater than 1500. The commenter stated that it will be very challenging to meet the food retail industry's need for reclaimed R-404A in 2028 and proposed that the mandate be postponed until 2030 at the earliest to avoid the certainty of commercial system shutdowns due to lack of refrigerant for servicing. The commenter argued that while the existing reclaim banks of all HFCs are currently inadequate to meet a servicing tail need in 2028, exempting refrigerants with GWPs less than 1500 from the reclaim mandate would serve to accelerate retrofits out of high-GWP refrigerants into HFC/HFO blend refrigerants like R-448A and R-449A, which would serve to quickly increase the amount of R-404A and R-507A especially. The commenter further claimed that including refrigerants like R-448A/R-449A in the reclaim mandate would remove all motivation for food retailers to retrofit high-GWP R-404A systems to R-448A or R-449A. The commenter stated that if it is clear when this regulation is finalized if there will be a way to service or maintain existing R-448A or R-449A equipment because if there are no reclaimed refrigerant available, food retailers will immediately stop using these refrigerants, and possibly start using higher-GWP refrigerants that are more likely to have significant banks of refrigerant available for service and maintenance. The commenter also noted that R-448A and R-449A are used today in new appliances, which are unlikely to reach their end-of-life until 2035-2040 at the earliest. The commenter stated that refrigerant is reclaimed at the end-of-life, so the only opportunity to establish banks of reclaimed refrigerant is when a new generation of appliances using those refrigerants begin to be retired.

The commenter noted that, while it is true that there are older appliance retrofits being carried out that use R-448A and R-449A, retrofitted appliances can be expected to continue to operate at least for an additional 10 years after the retrofit; otherwise, the cost of the retrofit cannot be justified.

Response: EPA responds and refers to the discussion in the previous response of this section related to a GWP-based exclusion for the reclaimed HFC refrigerant requirements at a GWP of 1,500. Further, the Agency is establishing that reclaim HFC refrigerant use requirements for the servicing and/or repair of certain refrigerant-containing equipment is being delayed by one year to January 1, 2029. EPA also responds, and as explained in prior responses, the Agency is not establishing reclaim use requirements for the initial fill of certain refrigerant containing equipment in this rulemaking, thus decreasing the need for additional supply of reclaimed HFCs and, in particular, reclaimed HFC or HFC blend refrigerants discussed in this comment.

EPA responds that setting such a GWP limit may have the opposite effect and that by not including all HFC containing refrigerants based on a GWP limit, there would be less incentive to recover and reclaim these blends. If the requirements were established such that R-448A and R-449A, for example, were exempted from the reclaim use requirements, there could be less incentive to properly recover these blends for future reclamation. Based on data reported to EPA on reclamation totals, these blends are currently being reclaimed to a degree, as are their components. EPA notes that while these or other newer blends may be under patent, the Agency is aware that there are certain agreements in place among producers and reclaimers to reclaim certain blends. Further, the Agency notes that it anticipates that with proper maintenance and adherence to the leak repair and ALD requirements, as applicable, in this rulemaking, leaks of HFCs should be minimized, decreasing the need for additional servicing of equipment.

EPA responds to comments related to retrofit. The Agency explains retrofit is considered as a servicing or repair activity in this rulemaking. For the subsectors that are required to use reclaimed HFC refrigerants for the servicing and/or repair of refrigerant-containing equipment (*i.e.*, supermarket systems, refrigerated transport, and automatic commercial ice makers), retrofits must be done with reclaimed HFC refrigerants if the refrigerant-containing equipment is being retrofitted to use a refrigerant that contains an HFC. Where a piece of refrigerant-containing equipment is being retrofitted to a substitute for an HFC, reclaimed refrigerant would not be required.

Comment: Two commenters provided comments recommending establishing exemptions from the reclaimed HFC refrigerant use requirements for those applications that receive application-specific allowances under the AIM Act.

Response: EPA responds to these comments related to providing exemptions in cases for which application-specific HFC allowances are provided under subsection (e)(4)(B) of the AIM Act. As discussed in section I.B, EPA is excluding mission-critical military end uses and onboard aerospace fire suppression from certain prohibitions for a year or years for which the application receives an application-specific allowance as defined at § 84.3. EPA is establishing requirements for the use of reclaimed HFC refrigerants in the supermarket systems, refrigerated transport, and automatic commercial ice makers subsectors. If mission-critical military end-uses and/or onboard aerospace fire suppression application-specific allowances were for HFCs used in the servicing and/or repair of refrigerant-containing equipment in these covered subsectors, then the exemption would apply.

This rulemaking establishes a definition for "refrigerant-containing equipment," which specifically does not include military equipment used in deployable and expeditionary situations.

Where reclaimed HFC refrigerants are required to be used for servicing and/or repair of certain refrigerant-containing equipment per this rulemaking, the requirements do not apply to the specific case of military equipment used in deployable and expeditionary situation.

Comment: One commenter suggested EPA move the January 1, 2028, compliance date back at least two years to allow for development of the necessary supply of reclaimed HFC refrigerants on the market. Another commenter supported the 2028 timeline for the implementation of reclaimed refrigerants and noted that EPA's firm rulemaking will help make a strong business case for scaling up separation technologies.

Response: EPA acknowledges these comments and responds that the Agency is delaying the compliance date for the requirements for the use of reclaimed HFCs in the servicing and/or repair of certain equipment to January 1, 2029. The Agency has reviewed comments and considers January 1, 2029, as an appropriate compliance date. The delayed compliance date provides industry more time to build up capacity of reclaimed HFCs available for these activities and for those required to use reclaimed HFCs to establish avenues to obtain the reclaimed HFC refrigerants. A compliance date of January 1, 2029, also aligns with the next major step of the phasedown under the AIM Act when virgin HFC production and consumption will be reduced to 30 percent of the baseline. Reclaimed HFCs will play a crucial role to support refrigerant-containing equipment using HFCs as this next step of the phasedown occurs.

Comment: EPA received many comments on the included subsectors for the requirements for use of reclaimed refrigerants for servicing and repair. One commenter recommended that EPA follow the approach taken by California's SB 120617 and implement reclaimed use requirements for all HFC sectors. The commenter stated that CARB adopted a prohibition on the sale, distribution, or otherwise entering the market, of newly produced bulk high-GWP HFCs, regardless of the sector. The commenter recommended that EPA take this comprehensive approach to establishing reclaim use requirements, since it would apply to bulk refrigerant used in all sectors, including retail food applications and non-space conditioning heat pump sectors such as clothes dryers, water heaters, and pool and spa heaters. The commenter also stated that since these technologies are projected to experience rapid adoption in the next decade, if they are not addressed in the 2023 Technology Transitions Rule, these sectors' equipment manufacturers may not be incentivized to transition away from high-GWP refrigerants.

One commenter recommended that EPA include residential AC, light commercial AC, heat pumps, cold storage warehouses, and IPR sectors to the service and repair reclaim use requirements if EPA does not take a comprehensive approach to include all sectors in the reclaim use requirements. One commenter requested that the proposed prohibition of virgin refrigerant usage for equipment servicing be limited to supermarkets, cold storage warehouses, refrigerated transport, and automatic commercial icemakers. Another commenter noted that many of these subsectors are already transitioning to ultra-low GWP alternatives for new equipment. The commenter stated that the supermarket sector in particular is anticipated to undergo significant near-term retrofits from high to low-GWP HFCs which will make large quantities of retired refrigerant available for reclamation and reuse in the refrigeration servicing market.

One commenter urged EPA to expand the servicing and repair reclamation mandate to additional sectors, specifically light commercial and residential AC and heat pumps. The commenter stated that the inclusion of this sector is essential to any material growth in recovery and reclamation as it has the greatest number of operating units and therefore the greatest number of pounds of refrigerant that can be recovered at the EOL. The commenter also suggested expanding the proposed rule to include smaller outdoor units would also increase the amount of reclaim recovered annually. The commenter suggested that EPA should focus the rule on system mandates, as opposed to mandates by sector. The commenter noted that this approach will help contractors better understand the reclaim refrigerant requirements by relying on the type of system and stated refrigerant charge. Moreover, the commenter claimed that, as the lower-GWP systems begin to be installed pursuant to the 2023 Technology Transitions Rule, EPA could then lower its GWP target below 1,000 GWP as stated in this suggested approach and create additional reclaim mandates for the lower-GWP systems. The commenter further stated that, as with the ODS phaseout, using the "worst first" principal creates significant reduction in the earlier years.

Some commenters expressed opposition to EPA's proposed mandate to use reclaimed gas for servicing various subsectors, specifically the retail food manufacturing and distribution sector. Multiple commenters expressed opposition to EPA's proposed requirements for HFC refrigerant reclaim in the retail food industry and other commercial refrigeration. The commenters stated that the cost of reclaimed HFC refrigerants will not be cheaper than new HFCs. Three commenters claimed that reclaimed HFCs are more expensive than HFCs because reclaimers incur significant equipment and operational costs, including HFC losses during reclamation, equipment upkeep costs, and costs associated with rebalancing refrigerants. One commenter stated that, since some industries are not required to use reclaimed HFC refrigerant, they will procure either new or used HFCs, depending on which is cheaper, so the price of reclaimed HFC refrigerant will always be at least as high as new HFCs. The commenter continued by stating that the proposed requirements will drive demand for reclaimed HFC refrigerant above that of new HFC refrigerant, likely causing them to cost more. Further, the commenter claimed that the use of reclaimed HFCs for equipment servicing and repair may be technically infeasible for custom-built equipment, particularly when upgrading or replacing components. The commenter stated that a limited supply of niche HFCs or blends not manufactured or reclaimed in significant volumes but essential for specific subsectors may also create compliance challenges. The other commenter expressed concerns that the mandate to use reclaimed gas for servicing will strand installed equipment if there is insufficient reclaimed gas to service the equipment. The commenter also noted that any time market supply and demand for a commodity are short, the price of that commodity will increase, and some consumers have to forgo the product, which the commenter stated would be especially unfortunate for equipment owners in the food manufacturing and distribution sectors. The commenter stated that any further disruptions or cost escalations to the food manufacturing and distribution sectors would increase already historically high food costs.

Response: EPA acknowledges these comments related to including additional subsectors in the requirements for using reclaimed HFCs in this rulemaking. At this time, the Agency is finalizing requirements for the use of reclaimed HFC refrigerants in the servicing and/or repair of refrigerant-containing equipment in the supermarket systems, refrigerated transport, and automatic commercial ice makers subsectors. The Agency is not finalizing requirements for use of reclaimed HFC refrigerants in the stand-alone retail food refrigeration subsector and not establishing requirements for the use of reclaimed HFC refrigerants in the initial fill of refrigerant-containing equipment in any subsector in this rulemaking. EPA is removing requirements for reclaimed HFC use servicing and/or repair of stand-alone retail food refrigeration equipment in part due to the nature of the equipment. EPA understands that these refrigerant-containing equipment are likely hermetically sealed and are less likely to need servicing and/or repair.

EPA is not establishing an approach for requirements to all RACHP subsectors. As described in other responses, EPA is considered available supply of reclaimed HFC refrigerants per these requirements. EPA is also establishing a reporting requirement to better assess the use of reclaimed HFCs in the RACHP subsectors covered in this rulemaking to evaluate the requirements in this rulemaking. The Agency acknowledges comments to establish an approach for all subsectors or to include additional subsectors and may consider additional subsectors in a future rulemaking.

EPA disagrees with the assertion that reclaimed HFCs are substantially more expensive than virgin HFCs and is not aware of market data or analyses clearly indicating such a trend. In response to the NODA, Relevant to Management of Regulated Substances Under the American Innovation and Manufacturing Act of 2020, in which EPA requested comment on current trends on the price of refrigerant, a major U.S. supplier noted "The market price for reclaim and virgin are generally equivalent. There is neither a "green premium nor a lower price for reclaim." EPA is also aware of at least one study indicating that reclaimed HFCs may actually be more cost-effective than virgin manufacture, when considering the full refrigerant lifecycle. In the analysis for the proposed ER&R rule, EPA referenced a study, Yasaka et al. (2023), which performed a life cycle assessment for the virgin production, destruction, and reclamation of R-410A, HFC-32, and HCFC-22 in Europe and Japan and found that the reclamation process had lower energy consumption and costs and emitted fewer GHG emissions compared to production and destruction, regardless of the refrigerant type or plant location. EPA is not aware of a similar study for the United States and so has conservatively assumed higher costs for reclaimed HFCs in the analysis for the final rule. Specifically, in its assessment of costs and benefits detailed in the RIA addendum and summarized above EPA has assumed a cost premium of 10 percent for reclaimed HFCs vis a vis virgin manufactured HFCs.

EPA notes that the commenter has not provided any quantitative information regarding a supposed cost increase in food prices resulting from refrigeration, or the effect that other factors such as refrigerant savings resulting from leak detection and repair provisions contained in this rule could have in mitigating such a cost increase.

EPA does not agree with the commenter's position that the requirement to use reclaimed refrigerant for servicing will strand installed equipment. The commenter suggests a scenario where there is an insufficient supply of reclaimed refrigerant. As EPA notes above, the Agency considers these provisions as encouraging increased reclamation. The Agency made changes from the proposal, including delaying the date and narrowing the required applications which the Agency considers as sufficient to address these concerns. The Agency does not agree that the provisions will result in unfavorable pricing for consumers. The Agency notes the overall phasedown of HFCs is more likely to affect the price of HFCs than these provisions.

Comment: Another commenter suggested that this proposal will create confusion by requiring the use of reclaimed refrigerants in certain sub-sectors, while not requiring it in others even though some of these sectors use the same refrigerants. The commenter stated that, currently, based on EPA proposal, stand-alone retail food refrigeration, supermarket systems, refrigerated systems, refrigerated transport, and automatic ice makers are required to use reclaimed refrigerants, but cold storage warehouses and IPR are exempt. The commenter suggested that the refrigeration reclaim usage requirements are not separated by subsectors. The commenter noted that the use of reclaimed refrigerants in imported equipment depends on the availability of recovered HFCs in the exporting countries and that it may be challenging to prove the authenticity of reclaimed refrigerants abroad. The commenter stated that these two factors could amount to an import ban for equipment with reclaimed HFCs. The commenter therefore requested that imported equipment be exempted from the mandatory use of reclaimed refrigerants.

Another commenter stated that the NPRM did not address how reclaim requirements would apply to imported units and HFCs. The commenter questioned what the effects of reclamation in other countries would be upon capacity in the United States' market and suggested that EPA should not provide offshore producers with an advantage.

Response: EPA responds to comments about the requirements for using reclaimed HFC refrigerants for servicing and/or repair of refrigerant-containing equipment by noting that these types of provisions are within the authority under subsection (h) to promulgate regulations to control practices, process, or activities related to the servicing, repair, disposal, or installation of equipment. EPA disagrees that by requiring reclaimed HFC refrigerants be used for the servicing and/or repair in certain RACHP subsectors and not others would create confusion. The Agency is establishing labeling requirements for containers of reclaimed refrigerants that contain HFCs (as discussed in section IV.E.1) such that equipment owners and operators can verify they are using reclaimed HFC refrigerants for servicing and/or repair of refrigerant-containing equipment in the supermarket systems, refrigerated transport, and automatic commercial ice maker subsectors. Further, EPA clarifies that this rule would not preclude the use of reclaimed HFC refrigerants in any manner. Consistent with the proposed rule and EPA's experience in the use of reclaimed ODS refrigerants, EPA anticipates that reclaimed HFC refrigerants will continue to play an increasingly significant role in the servicing and/or repair of existing equipment that use HFC refrigerants as the phasedown on production and consumption of virgin HFCs progresses.

EPA responds that the Agency is not establishing requirements for the use of reclaimed HFCs in the initial fill of equipment at this time.

Comment: One commenter proposed an alternative where EPA could finalize a program to define a "service gas" to distribute the finite reclaimed HFCs across the entire service market, and in this alternative, exclude first fill requirements with reclaimed HFC refrigerants. The commenter further claimed that EPA could require a minimum percentage of reclaimed HFCs (with consideration of the 15 percent limit, by weight, on virgin HFCs) be used in service gas sold to the aftermarket. The commenter further suggested requiring that all reclaimed HFCs be recovered from equipment manufactured in the United States(excluding equipment meeting GWPs under the 2023 Technology Transitions Rule and first fill requirements), claiming that this would maximize reclaim across the full market, maintain free market competition, return reclaimed higher GWP refrigerants to service, and maximize reclaim as recovery rates grow over time. The commenter recommended that EPA consider different service levels by market sector, exempting IPR because of its requirement to continuously maintain temperature ranges.

A couple of commenters discussed the feasibility of EPA creating a new service gas category for refrigerants. One commenter requested that EPA reject arguments that reclaim goals cannot be met due to challenges in recovery practices and that a new service gas category can be used in the secondary market (that is less than 85 percent reclaim). The commenter contended that such arguments were intended to cast doubt on the ability of reclaimers to provide sufficient reclaimed refrigerant. Another commenter suggested that a limit on virgin refrigerant could thwart reclaim goals and restrict uses like a "service gas" where an increasing percentage of reclaimed refrigerant could be used over time.

Response: EPA did not propose and is not finalizing the creation of a service gas category for refrigerants as EPA does not agree that the creation of a service gas category is necessary. EPA acknowledges that under the CAA Title VI phaseout ODS regulations virgin HCFCs can be produced and imported in very small quantities solely for purposes servicing certain appliances. For example, today under the "servicing tail" requirements, EPA issues allowances that allow for no more than 0.5 percent of the U.S. HCFC baseline to be produced and imported and that those HCFCs must be used solely for servicing with and further limits the allowances to only the two HCFCs with the lowest ozone-depleting potentials (*i.e.*, HCFC-123 and HCFC-124). The structure of the AIM Act and the CAA differs significantly in this area and in particular, the AIM Act's phasedown and not phaseout of HFC production and consumption is a stark difference from the ODS structure resulting in a need for a different approach with regards to servicing. EPA does not agree conceptually with a new category of gas that has a percentage of reclaimed material between a "virgin regulated substance" and "reclaimed refrigerant." It is EPA's view that the creation of this new category could create unnecessary complications in the market and could weaken the demand for reclaimed refrigerant rather than strengthening it. As EPA explains in section IV.E.1, the Agency is establishing a standard for the limit on the percentage of virgin HFCs, by weight, in reclaimed HFC refrigerants. EPA explains that, in addition to supporting maximizing reclaim, this standard helps to provide a consistent understanding of what constitutes reclaimed HFCs for their use in refrigerant-containing equipment. EPA views that a service gas category as described by the commenter would be detrimental to this, such that the service gas category would be introducing refrigerants with more virgin HFCs than would be in reclaimed HFC refrigerants meeting the standard established in this rulemaking. Such a service gas category would contradict the goal of maximizing reclamation by allowing more virgin HFCs in the servicing and/or repair of refrigerant-containing equipment. Further, EPA anticipates that this approach would require additional recordkeeping, and potential reporting, to confirm particular owners and operators were using a service gas of a specified percentage of reclaimed HFCs. Where the commenter states that varying percentages of reclaimed HFCs could be in service gas by subsector, the Agency responds that this could create confusion on the market. Equipment owners and operators would be required to ensure that the correct service gas was being used to service and/or repair their refrigerant-containing equipment depending on the subsector they are in. The established requirements for the standard on reclaimed HFC refrigerants avoids this confusion by ensuring there is a consistent understanding of reclaimed HFC refrigerant on the market. This standard and the established labeling requirements (discussed in section IV.E.1) properly support the requirements to use reclaimed HFC refrigerants for servicing and/or repair of refrigerant-containing equipment in certain RACHP subsectors, such that equipment owner or operators in these subsectors can be sure that the reclaimed HFC refrigerants comply and can be used to service and/or repair their refrigerant-containing equipment.

As explained in other responses in this section, the provisions that EPA is finalizing to require that reclaimed HFCs be used in the servicing and/or repair of refrigerant-containing equipment in certain RACHP subsectors is within the authority of subsection (h) of the AIM Act. EPA also notes that we discuss considerations and respond to comments related to establishing the reclaim servicing and/or repair provisions with a GWP limit (including considering those GWP level established in the 2023 Technology Transitions Rule). The Agency is not establishing GWP-based cut-offs for reclaimed HFC refrigerants for the provisions in this rulemaking for servicing and/or repair of refrigerant containing equipment in certain RACHP subsectors.

Further, the Agency is not establishing requirements for reclaimed HFC refrigerants in the initial fill of any refrigerant-containing equipment in this rulemaking.

Comment: Several commenters expressed concern about patent and intellectual property issues with reclamation. One commenter recommended that EPA provide an exception for certain newer and commonly used low-GWP refrigerants such as R-448A/R-449A and R-407A, given that they are unlikely to be reclaimed in sufficient quantity to satisfy industry needs, as these substances have only recently started to be used in newly installed or retrofitted in commercial refrigeration systems. The commenter further claimed that these refrigerants are subject to patents held by their manufacturers, thus not all reclaimers can legally formulate their blends, which will constrict supply. The commenter also stated that the proposed rule does not clarify EPA's analysis with respect to patent issues when carrying out HFC reclamation activities. Another commenter requested that EPA exclude patented or IP-protected products from these requirements. One commenter argued that a portion of reclaimer recovered refrigerants are patented and cannot be reclaimed to AHRI 700 specifications without "rebalancing" through the addition of blend components. The commenter claimed that rebalancing puts reclaimers at odds with patent laws and the refrigerant producers. The commenter noted that if out of specification patented refrigerants fell under RCRA within a year the reclaimers would be unable to process the material and unable to store it. Another commenter expressed concern about intellectual property restrictions, particularly for new low-GWP refrigerants. The commenter stated that reclaimers would need to secure authorization from producers to re-blend recovered HFCs into mixtures. The commenter suggested that this would be a bottleneck in the supply of reclaimed refrigerant and that recovered refrigerant should be primarily utilized to service the installed base (*e.g.*, R-410A) instead of for the production of low-GWP blends (*e.g.*, R-32 from R-410A to blend R-454B). Another commenter pointed out that many refrigerant blends are patented and cannot be reclaimed until the patents expire which would make it impossible to supply the necessary refrigerants for this proposal.

One commenter recommended that the final rule exclude patented refrigerants form any reclaim requirements under subsection (h) due to the requirements' potential to create serious issues for patented blends and incentivize patent infringement. The commenter stated that licensing rights would need to be secured to sell patented blends. Alternatively, the commenter suggested that the reclaim mandates could compel owners or operators to prematurely decommission equipment, leading to high costs and waste, counteracting sustainability goals. Another commenter highlighted that other free market initiatives are already underway to support refrigerant recovery, reclaim, and recycling by U.S. companies exploring programs to enable the circularity of proprietary HFO blends. The commenter stated that EPA should not finalize any rule that incentives or requires patent infringement or authorizes reprocessing of patented blends when source material is unknown.

Response: EPA is also aware that some chemical producers have entered agreements with reclaimers which support additional reclamation particularly where patents may be in place.

EPA acknowledges there may be patents, licensing agreements, and other business practices may impact the ability of some reclaimers to reclaim certain refrigerants. The Agency saw a similar situation when the market shifted from ODS to HFC refrigerants and to some extent has seen it with each introduction of a new HFC blend. However, requiring as we are in this final rule, an upper bound of virgin HFCs, would not change whether or not a reclaimer could reclaim or introduce to commerce reclaimed HFCs.

Comment: Two commenter stated that the proposal to mandate the use of reclaimed HFCs in servicing/repair for certain subsectors exceeds EPA's authority in subsection (h) of the AIM Act, as the Act provides no authority for the Agency to single out specific subsectors to shoulder the increased costs of using reclaimed HFC refrigerants. The commenters noted that subsection (i) of the statute provides specific authority for EPA to "restrict, fully, partially, or on a graduated schedule, the use of a regulated substance in the sector or subsector in which the regulated substance is used," and that EPA has used that authority to promulgate specific requirements for subsectors in the 2023 Technology Transitions Rule. One commenter continued that subsection (h), the authority for this rulemaking, does not refer to "sectors" or "subsectors," giving no basis for EPA to treat subsectors differently in requiring the use of reclaimed HFCs. The commenter noted that this action exceeds the scope of EPA's AIM Act authority and is arbitrary and capricious within the meaning of the Administrative Procedure Act.

Two commenters stated that the proposed rule would regulate the "use" of HFCs, which would require fulfilling prerequisites under subsection (i) of the AIM Act, and that this rulemaking does not. The commenters stated that manufacturing a new unit or supplying refrigerant for servicing is not such a practice, process, or activity related to the servicing, repair, disposal, or installation of equipment. One commenter argued that subsection (h) provided one specific example for what would be "appropriate" - requiring servicing, repair, disposal, or installation to be performed by a trained technician. The commenter further stated that the same practices, processes, or activities are done for virgin or reclaimed HFCs and the requirement to use reclaimed HFCs is removed from subsection (h)'s example of what is appropriate – technician training. The commenter also argued that EPA's interpretation of subsection (h) was impermissibly broad and could cover "anything and everything" that has to do with HFCs as connected to equipment. The other commenter claimed that these practices do not include opportunities for reclamation. The commenter stated that EPA's justification under subsection (h) to require the use of reclaimed HFCs in certain applications to minimize the release of regulated substances is creating a situation where EPA's authority could theoretically become unlimited. The commenter gave a theoretical example of EPA requiring lower-GWP refrigerants in certain applications to 'minimize releases' of HFCs.

Response: EPA disagrees with the comment that the requirement to use reclaimed HFCs in servicing/repair for certain subsectors exceeds EPA's authority in subsection (h) of the AIM Act. EPA does not consider the authority conveyed in subsection (i)(1) or the use of the terms "sector" and "subsector" in subsection (i), to preclude EPA from tailoring its regulations under other provisions of the Act to particular sectors or subsectors, where it is appropriate and reasonable to do so. As noted elsewhere in this action, EPA interprets the AIM Act as providing separate and distinct regulatory authorities, which can be implemented in ways that reinforce and complement one another. In this final rule, EPA is requiring that the servicing or repair of certain equipment be done with reclaimed HFCs as part of regulations implementing its authority under subsection (h) of the Act. That provision directs EPA to promulgate regulations to control, where appropriate, any practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment that involves: a regulated substance, a substitute for a regulated substance, the reclaiming of a regulated substance used as a refrigerant, or the reclaiming of a substitute for a regulated substance used as a refrigerant. A requirement to use reclaimed HFCs in servicing or repairing certain equipment controls a practice, process, or activity regarding the servicing or repair of equipment and involves a regulated substance or the reclaiming of a regulated substance. This requirement also supports and encourages reclamation of HFCs and thus is consistent with at least one of the purposes identified in subsection (h)(1). Accordingly, this requirement is within the scope of EPA's authority under subsection (h). In contrast to the regulations established under the 2023 Technology Transitions Rule, in this rule, EPA is not restricting the use of specific HFCs in a sector or subsector, nor is it limiting the use of HFCs based on a GWP-threshold. Rather, it is requiring that the HFCs used in servicing and repair of refrigerant-containing equipment in certain RACHP subsectors meet criteria related to the processing of the HFC before it is used – specifically, requiring that the reclaimed HFC refrigerants meet specific purity standards and meet the established standards established in this rulemaking limiting virgin HFC content (see section IV.E.1). EPA identified the refrigerant-containing equipment subject to this requirement by sector or subsector in part to build on terms that are already familiar to the regulated community so that it is easier to understand how these requirements will apply. Nothing in subsection (h) requires that regulations established under (h) apply equally to all types of equipment. Such an interpretation would make little sense, as different types of equipment necessarily involve different practices, processes, or activities regarding their servicing, repair, disposal, or installation. EPA has explained its rationale for this action elsewhere in this preamble, and for those reasons, views this requirement as a reasonable measure to implement its authority under subsection (h)(1) of the Act.

In response to comments that state that subsection (h) provides one, specific example of what is "appropriate" to control, which the commenter states is technician training, EPA disagrees that the statutory language under subsection (h) narrowly defines technician training as the only appropriate practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment. EPA interprets the text at subsection (h)(1) to simply identify an example of a requirement that would fit within the scope of (h)(1), not as a limitation that would preclude establishing other regulations that are also within the scope of (h)(1). The fact that the statutory text says "including requiring, where appropriate ...." indicates that the example was not intended as a limitation, as "including" makes clear that what follows is a potential requirement contemplated under the statutory text but does not exclude other possibilities. Further, the phrase "where appropriate" in the parenthetical suggests that Congress contemplated that the Agency would consider whether such a requirement was appropriate before establishing it, not that Congress automatically assumed that any such requirement would necessarily be appropriate, much less be the only appropriate option.

Comment: Two commenters argued that EPA lacks authority over non-servicing actions under the AIM Act. The commenters claimed that EPA's proposal in section 84.112 to regulate the marketing and sale of HFCs in commerce upstream from the use of HFC gas in equipment is not reasonably within EPA's authority. In particular, EPA's proposal to restrict the sale of reclaimed gas in section 84.112(b) does not relate to servicing of equipment, but rather restricts the sale of reclaimed gas upstream from the equipment. EPA's rule would restrict any sale of reclaimed HFCs in lieu of virgin gas for any uses that are still available to virgin gas under EPA's various AIM Act regulations. One commenter claimed that EPA is going beyond its subsection (h) authority by implementing reclaim requirements that go beyond maximizing reclaim and minimizing emissions that occur during specified events such as servicing and repair, and that EPA only has explicit authority to regulate releases from equipment and to ensure safety of technicians and consumers. The other commenter further argued that read together, the terms that Congress used – "servicing, repair, disposal, or installation of equipment" – naturally refer to work performed on equipment, not to the design of the equipment or the choice of which refrigerant gas is used in the equipment, and that given the context of the statute, it is not natural (and therefore not reasonable) to describe the choice of what gas is used in equipment as a "practice, process, or activity." The commenter maintained that the choice or specification of what refrigerant gas to use to charge a system is simply not an "activity" as used in the statute, and that EPA's reading of the concept of "activity," which they characterize as overly expansive, would lead to unexpected and overbroad results if, for example, specification of equipment components is considered to be an activity and EPA could dictate the type of steel used in the refrigeration system or the energy efficiency of the system. The commenter argued that the mandate to use reclaimed gas when servicing or repairing equipment relates to the choice of which gas to use, not to the activities that are normally considered repair and servicing such as refrigerant recovery or charging gas (apart from the choice of using virgin or reclaimed gas), replacing parts, fixing coupling or seals, and further claimed that if Congress had intended to delegate to EPA the authority to dictate the type of refrigerant gas that can be sold in the marketplace, it would have provided express authority similar to that in subsection (i) relating to technology transitions. The commenter further stated that there is no indication in subsection (h) that Congress intended to give EPA ability to "eliminate virgin gas" and replace it with reclaim gas. The commenter further argued that had Congress intended to give EPA the power to do so, it would have "stated so in clear terms." There is no indication in the AIM Act that the reclaim provision was intended to trump the allowance program and technology transition provisions in this way. The commenter argued that in contrast, a narrower approach focused on equipment servicing is entirely consistent with the statutory goal of increasing reclaim, reducing emissions, and enhancing safety.

Response: The Agency disagrees with the comments that these provisions go beyond its authority under subsection (h) of the AIM Act. The AIM Act provides various grants of authority to EPA, which, while separate and distinct, can be implemented in ways that reinforce and complement one another. Under subsection (h), for purposes including maximizing reclaiming and minimizing the release of a regulated substance from equipment, Congress directed the Administrator to promulgate regulations to control practices, processes, or activities regarding the servicing, repair, disposal, or installation of equipment that involves a regulated substance and the reclaiming of a regulated substance used as a refrigerant. This final rule, including the requirements related to the use of reclaimed refrigerant in certain equipment, carries out this direction in subsection (h). The requirement to use reclaimed HFCs in servicing or repairing certain equipment controls a practice, process, or activity regarding the servicing or repair of equipment and involves a regulated substance or the reclaiming of a regulated substance. This requirement also supports and encourages reclamation of HFCs and thus is consistent with the purposes identified in subsection (h)(1). Accordingly, this requirement is within the scope of EPA's authority under subsection (h). While this requirement regulates the activities of the person performing the servicing or repair by requiring that the refrigerant used during servicing or repair meet certain criteria, Congress did not limit EPA's authority under (h)(1) to only servicing activities that are performed directly on equipment, but rather, as noted previously, authorized EPA to regulate a broader scope of processes, practices or activities *regarding* servicing, repair, disposal, or installation of equipment. The statutory term "regarding" is quite expansive and EPA interprets it broadly in this context. Selection of a refrigerant to be used in servicing and/or repair is an important part of the servicing or repair process, as not all refrigerants are compatible with all equipment, and it is critical to select a refrigerant for servicing or repair that can appropriately be used with the equipment being serviced or repaired. For example, it would not be appropriate to use a flammable refrigerant in equipment that is designed to only use nonflammable refrigerants, so selecting the appropriate refrigerant for recharging such equipment after repair is a vital part of the repair process. The commenter's hypothetical examples regarding EPA dictating the steel used in the refrigeration system or its energy efficiency are inapposite because neither of those choices appear to involve a regulated substance or substitute, nor the reclaiming of a regulated substance (or substitute) used a refrigerant. *See* subsection (h)(1)(A)-(D).

The limitation on selling, identifying, or reporting a refrigerant as reclaimed unless it meets certain criteria helps ensure that the refrigerant used to comply with the requirements for use of reclaimed refrigerant during servicing and repair of equipment actually contains HFCs that have had bona fide use in equipment and been recovered from equipment before being reclaimed. This provision helps ensure that the requirements in this final rule achieve their regulatory purposes of maximizing reclamation and minimizing release of HFCs from equipment. For instance, it gives assurance to a technician purchasing refrigerant for servicing equipment subject the requirement to use reclaimed refrigerant that refrigerant that is marketed as reclaimed refrigerant will meet EPA's regulatory requirements. Under EPA's interpretation of subsection (h), the practices, processes, or activities regulated by this provision have sufficient relation to servicing or repair of equipment to also be within the Agency's authority under subsection (h)(1). Because EPA is not finalizing the proposed requirement to use reclaim in the installation of refrigerant-containing equipment, it is not responding to comments concerning its authority for that provision.

Contrary to the commenters' assertions, EPA further notes that this provision does not restrict the sale of all refrigerants in the marketplace, but rather only applies to those refrigerants that are being sold, identified or reported as reclaimed. Further, these requirements do not mandate elimination of virgin gas from the supply chain, but rather prevents it from being sold, identified or reported as reclaimed refrigerant and limits its use in servicing or repairing certain refrigeration-containing appliances. Moreover, this final rule does not reflect an approach that would "trump the allowance program and technology transition provisions" but rather contains requirements that are designed to serve the direction and purposes in subsection (h). Finally, EPA acknowledges the commenters' suggested approaches to refrigerant management that it believes EPA should adopt. Some of those suggestions are consistent with regulations that EPA is finalizing in this action; others reflect approaches that EPA did not propose and is not finalizing in this action, but which may be considered in the future under subsection (h).

Comment: A few commenters argued that the proposed rule, if finalized, would improperly accelerate the phasedown of HFC production and import for specific sectors by restricting HFC use in those sectors to 15 percent of (baseline) levels for repair and servicing in contravention to the AIM Act and the HFC phasedown regulations. The commenters claimed that the proposed rule effectively mandates an 85 percent reduction of production and import of HFCs for use in those sectors by 2028, which is substantially faster than the 40 percent reduction in 2028 required by the AIM Act. While the commenters recognized that the proposed acceleration is limited to certain subsectors and activities, the practical implications are much broader because HFCs are specific to end-use. The commenters requested that EPA reconsider the reclaim requirements because the AIM Act does not authorize such an acceleration of the HFC phasedown in these sectors, there is not sufficient evidence that supply of reclaimed HFCs can meet demand for the specific sectors, and that the mandate will increase HFC prices in the sectors resulting in harm to consumers.

Another commenter stated that the possible outcome suggested in the Draft RIA addendum for the proposed rule that the requirements for the use of reclaimed HFCs in refrigerant-containing equipment in certain RACHP subsectors would reduce the need for production of refrigerant. Further the commenter cited that the high additionality case in the Draft RIA addendum showed environmental benefits related to reduced consumption. The commenter stated to the extent that occurs, it would be an improper acceleration of the phasedown in contravention with subsection (f). The commenter, however, also suggested that EPA separately consider accelerating the HFC phasedown pursuant to subsection (f) as a means of supporting reclamation. The commenter stated that there currently is an excess of HFCs available in the market due to stockpiling and soft demand for RACHP equipment. The commenter mentioned that the current over-supply of HFCs discourages reclamation. The commenter suggested that a 10 percent step down in each of 2027, 2028, and 2029 would help prevent the shock of a sudden drop in supply and encourage reclamation.

Response: The Agency responds by noting the AIM Act provides various grants of authority to EPA, which, while separate and distinct, can be implemented in ways that reinforce and complement one another. As explained elsewhere in this notice, the requirements to use reclaimed HFCs in servicing or repair of certain refrigerant-containing equipment is being finalized under subsection (h) of the AIM Act, consistent with the direction and purposes identified in that section. The Agency did not propose to and is not accelerating the HFC phasedown through this action nor does the RIA addendum analyze an acceleration of the HFC phasedown. Rather, HFCs will continue to be available consistent with the phasedown codified at 40 CFR part 84, subpart A. Even if commenters' contention were correct that these requirements would in effect reduce the production or consumption of HFCs used in particular sectors or subsectors faster than the scheduled reductions under the Act, that does not make this rule an acceleration under subsection (f). Subsection (f) addresses EPA Administrator's authority to "promulgate regulations that establish a schedule for phasing down the production or consumption of regulated substances that is more stringent than the production and consumption levels of regulated substances required under subsection (e)(2)(C)" and the requirements for such regulations. As discussed in greater detail elsewhere in this notice, subsection (e)(2)(C) establishes an economy-wide phasedown schedule from baselines that are established pursuant to subsection (e)(1)(A) "for all regulated substances in the United States," and the production and consumption phasedown is implemented on an exchange value-weighted basis (rather than establishing caps for particular HFCs). This rule does not change the phasedown schedule, alter the amount of HFC production and consumption allowed in any year on an exchange value-weighted basis, nor does it alter the number of allowances that EPA will allocate in a future year. Further, it does not prohibit any production or import of any HFC. Instead, this provision governs specified processes, practices, and activities concerning the use the HFCs in servicing or repair of certain equipment. in specific subsectors.

EPA notes that consideration of accelerating the phasedown under subsection (f) of the AIM Act is beyond the scope of this rulemaking and thus the comment suggesting that EPA consider such an acceleration requires no further response.

Regarding the claim that the supply of reclaimed HFCs cannot meet the demand, we note that the RIA addendum and Economic Impact and Benefits TSD examined such supply. While our analysis does show that the amount of HFCs reclaimed in 2022 (latest year available) was less than the estimated demand, the data showed a significant increase in HFC reclamation compared to the previous year and that if this trend continued, there would be enough reclaimed

HFC to meet the projected demand many times over. Further, in those documents we evaluated the expected amount of HFCs from equipment coming out of service when the requirements to use reclaimed refrigerant when servicing certain subsectors take effect, and see that such amounts, if reclaimed, could provide the demand on a chemical-by-chemical basis. Further, nothing in this rule prevents reclamation of chemicals in compliance with the definition in this rule before the use of reclaim requirements take effect. Reclaimers or users may then choose to hold such materials for any expected demand later on, meeting the recordkeeping and reporting provisions that apply to such material.

In the RIA addendum and Economic Impact and Benefits TSD, the Agency assumed an increase in price for reclaimed refrigerant compared to virgin refrigerant. Based on comments received, we also provided a sensitivity analysis under which we assumed cost parity between reclaimed and virgin refrigerant.

Comment: Two commenters recommended that EPA consider an accelerated reclaim refrigerant requirement for federally owned equipment or buildings to lead by example and stimulate reclaim market expansion. One of the commenters recommended this as a pilot program to assemble real world data on costs and various issues. The commenter stated that a pilot could allow the validation of the Agency's assumptions about reclaim supply without risking adverse consequences. The commenter claimed that imposing a requirement for the use of reclaimed HFCs on federal departments and agencies would allow EPA to assess the feasibility and resulting costs without imposing a widespread requirement nationwide. The commenter claimed that such a pilot would allow for the assembly of verified data and lead to "lessons learned" and the refinement of resulting regulation, minimizing any consumer and community impact that EPA may not have considered. Another commenter pointed to California as an example where reclaim requirements were implemented for state owned or operated equipment and noted the large number of buildings owned or leased by the federal government. Another commenter noted that many large-scale purchasers are already purchasing reclaimed refrigerants and encouraged the General Services Administration and other federal agencies to continue to support the reclaim market. Another commenter stated that the Biden Administration previously announced that the General Services Administration would review contracts to support the use of reclaimed refrigerants in facilities.[94]

Response: EPA appreciates the suggestion for a program aimed at federally owned buildings. The Agency will share with other relevant federal entities, including the General Services Administration, these comments encouraging a federal program. While such a program is out of scope for this rulemaking and thus requires no further response, the Agency does note that for the leak repair provisions, the Agency did not propose and is not finalizing flexibilities that allow for additional time for federally-owned building that is allowed under the related CAA 608 regulations.

Comment: One commenter stated that, if EPA finalizes any of the proposed reclaim requirements, EPA should: a) require contractors to maintain records (subject to audit) of the quantity and type of refrigerant recovered and used to service equipment, b) require OEMs, distributors, reclaimers, and other allowance holders to annually report on the quantities of refrigerant recovered, reclaimed, disposed of, and introduced into commerce, and c) review EPA's program, including opportunity for public comment, by October 1, 2026, and finalized

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[94] The White House, "FACT SHEET: Biden Administration Combats Super-Pollutants and Bolsters Domestic Manufacturing with New Programs and Historic Commitments," The White House, September 23, 2021, available at: *https://www.whitehouse.gov/briefing-room/statements-releases/2021/09/23/fact-sheet-biden-administration-combats-super-pollutants-and-bolsters-domestic-manufacturing-with-new-programs-and-historic-commitments.*

revised standards by 2027. The commenter also requested that EPA "condition the effectiveness of such requirements on the development of new certification standards for contractors."

Response: EPA responds to this comment that the Agency solicited comments in an ANPRM related to technician training, certification, and other considerations. The Agency acknowledges the comment related to requiring certain recordkeeping and/or certification standards for contractors, and considers this comment related to the ANPRM. As such, the Agency is not addressing the comment at this time.

As discussed earlier in this section, EPA is establishing a discrete reporting requirement for relevant data to be submitted to the Agency to evaluate the availability of reclaimed HFC refrigerants being supplied for servicing and/or repair of refrigerant-containing equipment in the supermarket systems, refrigerated transport, and automatic commercial icemakers subsectors. EPA is establishing these reporting requirements to be prior to the compliance date of the requirements for reclaimed HFC refrigerants used for servicing and/or repair in these subsectors. EPA intends to consider the reported data and evaluate the requirements that begin as of January 1, 2029.

Comment: One commenter claimed that subsection (h)(2) does not give EPA authority to require the use of reclaimed substances or substitutes. The comment stated that subsection (h)(2) simply provides that "[i]n carrying out this section" EPA is to "consider the use" of authority under "this section" with regard to opportunities for reclaim. The commenter asserted that this provision must be read within its statutory context and does not provide EPA with authority to utilize authority contained outside of subsection (h). The commenter stated that subsection (h)(2) is "most naturally read" to mean that when instituting regulations relating to servicing, repair, disposal, or installation of equipment, EPA consider opportunities for refrigerant reclamation.

The comment also stated that EPA cites no legislative history to support a broader interpretation of (h)(2), and asserts that EPA is arbitrarily creating an unauthorized, mandatory market for reclaimed HFCs based on its reading of the purposes of this section, while simultaneously claiming that market forces alone will increase the amount of reclaimed HFCs available. The commenter further stated that there is no ‘market failure’ for EPA to correct via regulation, and that market forces should take precedence.

Response: Although the comment does not specify which part of subsection (h)(2) of the AIM Act the comment is referencing based on the excerpt quoted, which appears in subsection (h)(2)(A) of the Act, the Agency interprets this comment to relate to subsection (h)(2)(A) but not subsection (h)(2)(B), which as discussed elsewhere in this notice pertains to reclamation of recovered HFCs refrigerants. As discussed in the proposal and in this final rule, the Agency has considered the use of authority available to the Administrator to increase opportunities for reclamation of HFCs used as refrigerants in developing the requirements established in this rule. As this action is taken under subsection (h) of the Act, EPA need not address the application of subsection (h)(2)(A) to other subsections of the AIM Act, and to the extent that the comment relates to other subsections of the Act it is beyond the scope of this rulemaking and thus requires no further response. As discussed in more detail elsewhere in this preamble and in other responses to comment, EPA interprets the requirements established in this final rule to perform servicing and/or repair of certain appliances in certain sectors or subsectors with reclaimed HFCs as being within the scope of its regulatory authority under subsection (h)(1) of the Act. Subsection (h)(1) of the AIM Act directs the Agency to establish regulations to control, where appropriate, practices, processes, or activities regarding the servicing or repair of equipment that involves a regulated substance or the reclaiming of a regulated substance used as a refrigerant.

The relevant provisions in the final rule control the servicing and/or repair of certain equipment by requiring that it be done with reclaimed HFCs and thus are within this authority and support the purpose of maximizing reclaim of HFCs. This interpretation is based on the text of subsection (h), as the available legislative history for the AIM Act is very limited, and the commenter does not cite any statutory text or legislative history to suggest that this interpretation is inconsistent with Congressional intent. Given that the statutory text in subsection (h)(1) identifies particular purposes for regulations established under this provision, it is reasonable to consider those purposes in establishing such regulations, as EPA is doing in this rule. The Agency disagrees with the commenter's assertion that these requirements arbitrarily create an unauthorized, mandatory market for reclaimed HFCs. While EPA acknowledges that existing market dynamics may incentivize the use of reclaimed refrigerants over time, as explained elsewhere in this final rule disagrees with the conclusion that those possible incentives mean this requirement is unneeded or that those market dynamics mean that the Agency should not establish these requirements. Congress put particular weight on reclamation in subsection (h) of the AIM Act, including through the provisions of (h)(1) and (h)(2)(A) referenced previously in this response. Even assuming that market dynamics or implementation of other programs lead to some additional use of reclaimed refrigerant over time, the comment did not provide any reason to think that those factors alone would "maximize" reclamation as stated in subsection (h)(1). It is the Agency's view that the reclaim requirements established in this action will help increase reclamation and support additional recovery of HFC refrigerants and are within its authority under subsection (h) of the Act and will help serve the purposes identified in that subsection.

Comment: One commenter requested that EPA revise its proposed language in sections 84.112(e) and (f) to specify that all permissible substitutes will continue to be allowed for servicing and repair. The commenter stated that EPA's proposed regulatory language in sections 84.112(e) and (f) could be read to require that refrigerant-containing appliances in the identified subsectors may only be serviced and repaired with reclaimed HFCs, to the exclusion of substitutes.

The commenter stated that robust demand for reclaimed HFC refrigerant already exists and will continue to grow significantly due to the AIM Act's phasedown of HFCs. The commenter requested that EPA revise its proposed language to specify that all permissible substitutes will continue to be allowed for servicing and repair and include a regulatory exception to relieve the obligation to comply where there is an inadequate supply of reclaimed HFCs to meet service and repair needs in the identified subsectors.

Response: EPA responds that substitutes for HFCs can be used in the servicing and/or repair of refrigerant-containing equipment in the RACHP subsectors included in this rulemaking (i.e., supermarket systems, refrigerated transport, and automatic commercial ice makers). The proposed regulatory text at 84.112(f) was intended to require that the servicing and/or repair of refrigerant-containing equipment in these subsectors must be done with reclaimed HFCs, where those refrigerant-containing equipment use a refrigerant containing an HFC, but would not apply where the refrigerant contains no HFCs or to any non-HFC constituents in the refrigerant. For example, if an existing supermarket system uses CO_2 as the refrigerant, it would not be required to use reclaimed HFC refrigerants for servicing and/or repair of the refrigerant-containing equipment since such equipment is not using a refrigerant that contains an HFC. EPA is finalizing revisions to the regulatory text to make this intent clearer in response to this comment but does not view these edits as changing the substance of the provision. As discussed elsewhere in this preamble, EPA is not finalizing in this action the proposed requirement to use reclaimed

HFCs in the initial charge of new refrigerant-containing equipment and thus is not making parallel edits to that provision. For the reasons described in a prior response to comment in this section, the Agency does not agree that exceptions are needed from the requirements to service and/or repair existing equipment in the covered subsectors using reclaimed HFCs when there is an inadequate supply and thus is not finalizing such an exception. The Agency recognizes that commenter's points on the existing market for reclaimed HFCs and agrees with the commenter's views that this market will in fact grow. The Agency is finalizing provisions that do not counter market forces and other regulatory provisions that also support growth in reclamation.

Comment: One commenter suggested EPA allow the use of reclaimed refrigerant for servicing in 2025 to be credited against compliance obligations in future years. Another commenter requested that EPA confirm that exports of virgin HFCs be eligible under the Request for Additional Consumption Allowance (RACA) program, regardless of when the original HFCs or individual blend components were imported. The commenter added that it is critical that the RACA program, under 40 CFR 84.17, be available to obtain allocations for HFCs that can be used in the United States and that EPA has projected will be available in the market. The commenter stated that this is essential to minimizing stranded assets and preventing further disruptions to the market that would ultimately effectuate significant commercial harm to the after-market and ultimately to consumers).

Response: EPA disagrees with the suggestion that the Agency allow the use of reclaim refrigerants for servicing and/or repair in 2025 to be credited against compliance obligations for future years. The Agency did not propose and is not finalizing any sort of early crediting regime. EPA did discuss in the NPRM scaling the reclaim requirements for servicing and/or repair on a percentage basis, but as discussed in responses earlier in this section, the Agency is not finalizing that approach. However, EPA encourages early action to support the uptake of use of reclaimed HFC refrigerants ahead of the compliance date.

Comments or requests concerning the structure of the allocation program are beyond the scope of this rulemaking. However, the Agent notes, allowing entities to receive allowances for the reclamation of refrigerant would artificially inflate the number of allowances in the market.

EPA agrees that the RACA process is important to allowance holders in the United States. EPA is not modifying that RACA program in this rulemaking, and EPA notes that the reclamation requirements for servicing and/or repair of refrigerant-containing equipment in certain subsectors in this rulemaking will not impact the RACA program.

Comment: Another commenter recommended that EPA not replicate California's HFC programs because California state law has no bearing on how the Agency interprets the AIM Act and because their current R4 Program is short term in nature. The commenter stated that EPA should avoid adopting different regulatory provisions based on state law instead of the intentional design of the AIM Act. The commenter claimed that the R4 Program was created as an interim measure after CARB finalized sector control limits that could not be implemented by the effective date. The commenter suggested that EPA consult with OEMs to understand the complications and burden of the R4 Program when the first reports are due in July of 2024 and not to adopt provisions until after this. The commenter suggested that EPA consult with OEMs to understand the complications and burden of the R4 Program when the first reports are due in July of 2024 and not to adopt provisions until after this.

Response: EPA acknowledges these comments and responds that the Agency proposed a rule and is now establishing provisions based on that proposal that are in correspondence with the AIM Act, not a state's regulation or legislation. EPA referenced and reviewed multiple states' programs and policies in place or under consideration, including the California regulations, when developing the proposed rule. The Agency reviewed these regulations for informational purposes and awareness of what was being implemented under those programs; however, EPA did not propose and is not finalizing regulations that mirror fully any specific state requirements, nor was it the Agency's intent to do so. EPA consulted with many different stakeholders when developing proposal, including information from comments received on the Agency's NODA and through multiple webinars, and through the comment period, including from OEMs. EPA is finalizing requirements for the servicing and/or repair of refrigerant-containing equipment in certain RACHP subsectors and is not finalizing requirements for reclaimed HFC refrigerants in the initial fill of refrigerant. The Agency acknowledges that in many instances, the industry seeks alignment with Federal and state regulations. However, this regulation is being finalized consistent with, and to serve the particular purposes of and direction in, subsection (h) of the AIM Act, and EPA understands that states are promulgating regulations based on their state authorities.

Comment: EPA received a few comments on establishing requirements for refrigerant recovery. One commenter was disappointed that EPA did not propose requirements that would increase recovery of refrigerants from existing equipment, but instead focused requirements on increasing demand for reclaimed refrigerant. The commenter stated that government mandates are not needed to increase demand through the HFC phasedown and that such solutions will not maximize reclaim. The commenter also stated that there does not appear to be a bias for or against reclaimed refrigerant according to distributors, so the emphasis should be on increasing refrigerant recovery. The commenter suggested that, if mandates are put in place, such mandates should be visible to the technician community by creating access to reclaimed refrigerant to create an incentive to increase their recovery rates. The commenter claimed that technicians understanding that reclaimed refrigerant must be used in servicing and that no additional virgin material is allowed will have a better understanding of why recovery is required.

Another commenter stated that not only is recovered refrigerant not reaching reclaimers there also seem to be stockpiles not turned in to reclaimers. The commenter also stated that they have heard that it takes too long to recover refrigerant, especially R-410A. The commenter noted that this could be because of using the recovery equipment for R-22 instead of R-410A. The commenter suggested that EPA may want to consider using some of its funding for small contractors serving low and medium-income communities to apply for grants or to outright purchase the correct recovery equipment. The commenter further suggested that EPA may wish to interview contractors to better understand the challenges they face with recovery and price points to incentivize purchasing reclaimed refrigerant. The commenter noted that despite these relatively high prices, reclaim rates have never been above 5000 tonnes per year for HCFC-22, even with a complete ban on newly produced HCFC-22 for servicing, according to EPA's Summary of Refrigerant Reclamation.

One commenter states that the proposed rule did not pay sufficient attention to the role of recovery in maximizing reclamation. The commenter further proposed that, given the central role recovery plays, EPA should initiate a new rulemaking under subsection (h) of the AIM Act as soon as possible to ensure these and other issues related to recovery are adequately addressed before any further reclaim mandates are considered.

Another commenter recommended considering process enhancements to reduce refrigerant contamination before reuse or return for reclaim arguing that many reclamation facilities without fractional distillation capacities cannot separate components when contamination is above 15 percent. The commenter requested that EPA evaluate how much refrigerant is returned contaminated and how much is destroyed annually and integrate tools to reduce cross contamination to maximize the potential for reusing refrigerants.

One commenter stated that increasing the recovery of HFCs for reclamation is essential for economic growth and other environmental benefits, while another commenter stated the importance of mandates for increased recovery is needed to support reclamation. Another commenter noted that financial incentives for technicians may be effective to enhance recovery of HFCs. Another commenter stated that in addition to incentivizing recovery, regulations can be effective for enforcement of recovery of HFCs.

One commenter stated that the requirements for reclaimed HFCs would lead to increased demand for reclaimed HFCs and thus incentivize recovery of HFCs; however additional measures may also be needed to bolster recovery. The commenter requested that EPA consider establishing a standard for equipment used to recover refrigerant to control leakage during recovery.

Response: EPA responds to these comments that requirements established for the recovery of HFCs from equipment would be related to those requirements for technicians and contractors performing the actual recovery. EPA understands that critical link between recovery and reclamation and agrees that increased recovery of refrigerants supports the increased reclamation of those refrigerants. The Agency views requirements related to recovery as under the authority of subsection (h) of the AIM Act, as they are related to practices, processes, or activities relate to the servicing, repair, or disposal of equipment. Recovery of the refrigerant would likely be a practice, process, or activity required to remove the charge of refrigerant to repair the equipment or would be performed during the process of disposing the equipment to recover the refrigerant before it is disposed. EPA views such practices, processes, or activities as those performed by a technician or contractor, and the Agency refers to the ANPRM published related to technician training, certification, and other considerations. The Agency, thus, acknowledges these comments and will consider them for a future rulemaking under subsection (h) of the AIM Act.

EPA acknowledges comments related to using the proper recovery machines to recover refrigerants from equipment. EPA also notes that certified recovery equipment are required for such practices, as handled under other regulations under the CAA.[95] EPA acknowledges the comment related to grant funding for recovery equipment and note that such considerations are outside of the scope of this rulemaking. EPA agrees there is value in understanding challenges faced with recovery of refrigerants. As previously stated, EPA solicited comments in an ANPRM on considerations related to technicians and, while not addressing in this rulemaking, the Agency will review and consider for future rulemakings.

Comment: One commenter suggested that there is evident viability of on-site recycling during the refrigerant recovery process for HVACR appliances. The commenter stated that as long as HVACR technicians use AHRI 740 certified equipment and establish refrigerant identification protocols, the recycled refrigerant will be suitable for reuse within the same system. The commenter recommended that this industry learn from the successes that the MVAC industry has had with refrigerant reclamation. The commenter also recommended that there be a defined process to qualify refrigerant for reuse in the field alongside on-site analyses. In addition,

[95] EPA has established standards for recovery and/or recycling equipment under section 608 of the CAA for the service, repair, or disposal of appliances containing ODS and ODS substitutes (*e.g.*, HFCs) under 40 CFR 82.158. Additionally, EPA has standardized equipment for the servicing of refrigerant from MVAC systems under CAA section 609, and any technician servicing equipment for consideration must use approved refrigerant handling equipment pursuant to 40 CFR 82.36.

the commenter stated that a refrigerant identifier or analyzer should be present. The commenter noted that such measures are fundamental to the safe and proper recycling of refrigerants to mitigate risks associated with the use of unqualified or contaminated refrigerants and to provide an alternative to reclaiming all refrigerant extracted.

Response: EPA responds to this comment that on-site recovery and recycling is a current practice in industry, such that the recovered refrigerant is used in the same piece of refrigerant-containing equipment, or is recovered and used in another piece of refrigerant-containing equipment of the same owner. This practice is consistent with the requirements under 40 CFR 82.156(h), which are applicable to appliances containing ODS refrigerants as well as certain substitutes for ODS refrigerants (*e.g.*, HFCs). This rulemaking does not affect such practice and EPA notes that HFC refrigerants that are recovered can continue to be recycled to the same piece of refrigerant-containing equipment that the HFC refrigerant was recovered from or another piece of refrigerant-containing equipment under the same ownership.

EPA recommends but does not require the use of refrigerant identification technology in the servicing of AC systems. EPA agrees that refrigerant analyzers are an important tool to identify contaminated systems and to prevent a technician from charging the incorrect refrigerant into an AC system. While not addressed in this rulemaking, EPA considers this comment to fall under the scope of the ANPRM as it relates to considerations for technicians. As explained in section VIII below, EPA is not responding to comments related to the ANPRM in this final rule.

Comment: One commenter stated that the proposed rule disrupts the supply chain by creating a captive market where specific market transitions are mandated, losing economic incentives to lower the costs of products. The commenter claimed that the proposed rule requires that OEMs and technicians buy reclaimed HFCs, creating a closed market with a finite amount of reclaimed HFCs. The commenter claimed that EPA has not analyzed the cost impact of such an unbalanced, artificial market to end consumer, nor the potential concentration of a finite reclaimed HFC supply within a small number of suppliers. The commenter recommended that proposed mandates be validated by robust supply/demand modeling.

Response: EPA responds to the commenter's concerns for a closed market and relevant analysis. This rulemaking does not limit the production or consumption of HFCs. HFCs will continue to be produced and imported in accordance with the phasedown schedule. HFCs will be available to be sold and distributed for a range of eligible applications. It is likely that as the phasedown continues shifts in which HFCs are produced and imported will shift as well. The Agency notes and directs interested readers to the Allocation Framework Rule where the Agency discussed more fully use of an exchange valued weighted approach rather than a chemical-to-chemical approach to phasing down HFCs.

The Agency acknowledges that by requiring the use of reclaimed refrigerant in certain sectors and subsectors, the Agency is precluding the use virgin HFCs for servicing in those applications. The Agency disagrees that requiring the use of reclaimed refrigerant in certain sectors would create any sort of monopoly, as EPA has not mandated that stakeholders purchase refrigerant from any specific entity.

The Agency notes that there are over 50 certified reclaimers in the United States. Therefore, there will be sufficient competition amongst those reclaimers to supply reclaimed HFCs. The Agency further notes that there are only five HFC producers with production facilities in the United States and often there is only one facility producing each of the HFCs that are produced domestically with other HFCs only available through imports. Supply of virgin HFCs is significantly augmented by imports and on an annual basis between 2024 and 2028, there are, or will be, approximately 75 companies with EPA-issued consumption allowances that allow them to legally import virgin or reclaimed HFCs.

EPA has analyzed the compliance cost and benefits for using reclaim requirements in the RIA addendum included with this rulemaking. Results from this analysis indicate that requiring the use of reclaimed HFCs for the servicing of equipment covered by this rulemaking may result in incremental costs to industry while also reducing demand for virgin HFCs. This reduction in demand may in-turn reduce costs to industry by alleviating potential supply shortages, although EPA has not quantified such cost savings in its analysis. A study cited by EPA in the RIA addendum and comments EPA has received from at least one major supplier of HFCs also indicate that the use of reclaimed HFCs may actually be on-par-with or more cost-effective than the use of virgin HFCs. Therefore, EPA has included a sensitivity analysis in its RIA addendum in which the use of reclaimed HFCs is assumed to be cost-neutral.

Comment: One commenter claimed that the existing record does not show a current need for the requirements for the use of reclaimed HFCs in certain RACHP subsectors, noting that the proposed rule extols the successes of recycling and reclaiming Class II ODS. The commenter cites EPA's Updated Draft Report - Analysis of the U.S Hydrofluorocarbon Market: Stakeholders, Drivers, and Practices; September 2023 in arguing that the that the use of recycled/reclaimed HFCs was already anticipated as a path to compliance with the phasedown. Further, the commenter noted that among impediments to the U.S. reclaim market noted in the draft report, inadequate demand for reclaimed HFCs was not identified as such an impediment to the market. The commenter also stated that environmental benefits estimated for the requirements for using reclaimed HFCs are non-existent, and that the requirements could result in shifting allowance use to meet demand in other sectors and subsectors.

Response: EPA responds that the requirements for reclaimed HFC refrigerants in the servicing and/or repair of refrigerant-containing equipment in certain RACHP subsectors are being established under subsection (h)(1) of the AIM Act, which provides EPA with the authority to promulgate regulations to control, where appropriate, "any practice, process, or activity, regarding the servicing, repair, disposal, or installation of equipment" for purposes that include maximizing reclaiming and minimizing releases of HFCs from equipment. EPA views these requirements for using reclaimed HFC refrigerants in the servicing and/or repair of refrigerant-containing equipment as controlling a practice, process, or activity regarding the servicing and/or repair of such equipment, and as helping serve the purpose of maximizing reclaim, as the requirements present opportunities for increased recovery of used refrigerants and use of and demand for reclaimed HFCs and thus increased reclamation. Even assuming increased recycling or reclamation is anticipated to occur under the phasedown, the comment provides no reason to think that such voluntary increases alone would be sufficient to serve the statutory purpose identified in subsection (h)(1) of maximizing reclamation. To the extent that the comment suggests that EPA must demonstrate a particular degree or magnitude of current need to establish regulations under subsection (h)(1), EPA disagrees, as such a requirement is not explicitly stated in the statutory language of subsection (h). Nonetheless, for the reasons described earlier in this response and elsewhere in this final rule, the Agency concludes that these requirements are appropriate to serve purposes identified in subsection (h)(1) and to implement that provision.

EPA acknowledges that inadequate demand was not identified as a barrier to increased reclamation in the Draft Report. However, as the Agency explains in this rulemaking and consistent with the proposed rule, that these provisions are expected to drive additional recovery of HFC refrigerants and, thus, reclamation. EPA notes that the barriers described in the draft report were intended to capture the status of the reclamation industry and inform this rulemaking.

The Agency acknowledges that allowance use for virgin HFCs may shift related to the provisions established in this rulemaking. However, the Agency anticipates that any such shifts in use of allowance would be related allowances needed for difficult to transition applications where a path to substitutes for HFCs is less clear at this time. Further, even assuming such shifts occur, they do not provide a reason to not finalize the requirements in this rule. If anything, they merely provide an example of how implementation of this rule may also have the effect of assisting in supporting implementation of other programs under the AIM Act.

Comment: One commenter suggested that EPA did not analyze the economic cost and consumer pricing impacts of the HFC supply and demand mismatch. The commenter stated that EPA's awareness of impact without analysis is not consideration of relevant factors required by subsection (h). The commenter stated that the NPRM does not estimate the costs of resetting the market through new customer/supplier relationships, and the commenter further stated that restricting HFC quantities would increase refrigerant prices. The commenter stated that certain refrigerants from producers (*e.g.*, certain HFC-32 lines) may no longer be economically viable and stated that the NPRM should have considered the likelihood of stranding production assets. The commenter additionally argued that the reclaim mandate eliminates incentives to develop low-GWP blends with an HFC component. The commenter recommended that EPA base any reclaim requirement on robust and appropriate data.

Response: The HFC allowance allocation system is out of scope for this rulemaking; however, EPA reminds readers that the United States is phasing down HFC production and consumption. The overall phasedown of HFCs will result in changes in production and consumption of specific HFCs and blends. Furthermore, the commenter mischaracterizes the relevant factors for this rulemaking. The Agency has provided an analysis of the costs and benefits of this rule for informational purposes and to address EO requirements. We do not rely on this information as a record base for this rule and would have reached the same conclusions without this analysis. Instead, the statutory requirement under subsection (h) is for purposes of maximizing reclaiming and minimizing the release of regulated substances from equipment and ensuring the safety of technicians and consumers.

EPA disagrees that the proposed rule disincentivizes the development and deployment of low-GWP blends. As noted elsewhere, the overall phasedown of HFC production and consumption as well as the 2023 Technology Transitions Rule, will affect both the overall supply and demand for virgin HFCs. The Agency does not agree that this rule results in a mismatch of supply and demand. Nor does the Agency consider this rule as contributing to a disincentive for U.S. innovation. The Agency further notes that innovation can come in many forms. It could be the introduction of new chemistry and it also could include better and more efficient ways to recover and reuse HFCs, including through HFC reclamation technologies.

Further, EPA is establishing a reporting requirement in this rulemaking for information related to the availability of reclaimed HFC refrigerants in the supermarket systems, refrigerated transport, and automatic commercial ice makers subsectors. EPA intends to assess the reported data and consider further evaluating the established requirements for reclaimed HFC refrigerants in the servicing and/or repair of refrigerant-containing equipment in these subsectors.

Comment: One commenter expressed concern that there is no plan for banned virgin refrigerants that can no longer be used for service in the proposed sectors. The commenter claimed that these virgin refrigerants would have no value. The commenter stated that EPA has not done research to determine the quantity of HFCs currently stockpiled in the country (imported before the AIM Act) and that this quantity is large. The commenter recommended a carbon credit program for destroyed HFCs and stated that without such a program the price of virgin HFC will drastically decline as distributors with stockpiles sell this material, limiting the amount of system retrofits to lower-GWP refrigerants. The commenter noted that this would continue until late 2027 at which point companies would be forced to change or use expensive and scare refrigerant to service equipment, leaving considerable virgin material with no value and no destruction and carbon credit program. The commenter questioned if there was a need to speed up the HFC phase down that is already in place.

Another commenter argued that the requirements for using reclaimed HFC refrigerants for refrigerant-containing equipment in certain RACHP subsectors could have adverse effects on existing allowance holders by denying them customers and therefore harming business plans and investments.

Response: The Agency notes that it has been more than 30 years since the CFC phaseout and yet there is still demand for reclaimed CFCs. In addition, separation technology is available and used by some reclaimers, which allows refrigerant blends to be separated into component refrigerants. These components could then be used neat or in other blends. One example of this is the separation of R-410A into HFC-125 and HFC-32. HFC-32 could be used neat and HFC-125 could be used in other blends with GWPs below the 2023 Technology Transitions rule restrictions or in other applications.

The Agency disagrees with the need to establish a destruction program for virgin HFCs for generating carbon credits. EPA discusses this in a prior response in this section, noting that any such program would need consider the additionality of the destruction of HFCs and that such considerations are outside of the scope of this rulemaking. EPA notes that the phasedown of production and consumption addresses virgin HFCs. Regarding comments about stockpiling of HFCs in the United States, the Agency responds that this is addressed under regulations under the Allocation Program (i.e., the Allocation Framework Rule and the 2024 Allocation Rule). The 2024 Allocation Rule provides additional detail related to assessing stockpiling and how that is considered in the methodology for allocating allowances. EPA notes allocation of allowances is out of scope for this rulemaking.

EPA disagrees that the requirements for reclaimed HFCs in the servicing and/or repair of refrigerant-containing equipment in certain RACHP subsectors would drastically disrupt current allowance holders business plans. EPA is not establishing requirements for reclaimed HFC refrigerants in the initial fill of any refrigerant-containing equipment in this rulemaking. Such requirements are only for the servicing and/or repair of refrigerant-containing equipment in certain RACHP subsectors. Most of these existing equipment are currently using refrigerants that contain HFCs that have been in equipment for an extended period of time. As such, these refrigerant-containing equipment are likely to continue to rely on reclaimed HFCs as the phasedown progresses. EPA does not dictate how allowance holders use their allowances, but understands that some may use allowances for refrigerants that contain HFCs that would be compliant with the 2023 Technology Transitions Rule. Further, EPA is establishing a compliance date of January 1, 2029, for the requirements for reclaimed HFC refrigerants for servicing and/or repair of refrigerant-containing equipment in certain RACHP subsectors. This period of over four years provides entities with time to secure and adjust business relationships as needed.

Comment: One commenter recommended that, if after each three-year period (starting in 2028) EPA requires each consumption allowance holder to acquire a quantity in exchange value equivalent (EVe) metric tons of reclaimed HFCs produced by any U.S. reclaimer equal to a portion of their consumption allowance allocation (capped at a maximum five percent to reasonably balance the supply of reclaimed material with consumption holder demand) and the program remains necessary, then the percentage be adjusted for the following three-year period based on changes over the prior three-year period in reclaim capacity and availability, the supply of HFCs, and market demands. The commenter stated that the program could include exemptions for *de minimis* allowance holders and economic hardships, such as lack of reclaimed HFCs in the market or unreasonable prices.

Response: EPA responds that this comment of scope for this rulemaking. EPA did not propose or seek comments on changes to the allowance system codified at 40 CFR part 84, subpart A.

Comment: One commenter stated that if EPA goes forward with these requirements, it should make grant funding available to offset the increased costs associated with purchasing reclaimed HFC refrigerant, and the requirement should be imposed only on grant recipients.

Response: EPA notes establishment of grant funding is outside the scope of this rulemaking.

Comment: One commenter expressed concern that the proposed rule could impact smaller businesses by adding tasks for recovering HFCs and for related logistics and that burdensome demands coupled with potentially unrealistic reclaim targets may divert resources from core operations and stifle innovation of the value chain.

The commenter further stated that requirements for reclaimed refrigerants at the OEM level is impractical, and that the Agency should shift its regulatory scope to focus on chemical producers and importers, which could allow the Agency to reduce its burden on small businesses and reduce supply chain disruptions and costs. The commenter stated that it will be difficult for the Agency to achieve its goal of regulating anyone who produces, imports, reclaims, repackages, or fills a container with a regulated substance used in servicing, repair, or installation of equipment by regulating at the wholesaler/distributor or contractor level. The commenter argues that doing so would require extensive container tracking and reporting frameworks alongside enforcement mechanisms. The commenter claimed that since a majority of wholesalers and contractors are small business, EPA would have to complete the EPA's Small Business Ombudsmen assessment. Additionally, the commenter claimed EPA would have to regulate over 1,000 wholesalers/distributors and 200,000 contractors, making enforcement more difficult. Additionally, the commenter stated that EPA would require significant support from industry, potentially delaying implementation.

Alternatively, the commenter stated that EPA should regulate reclaim at the producer/importer level. The commenter mentioned that chemical producers/importers are already regulated under the AIM Act, and that these entities already have established infrastructures to report sales, imports, and the production, destruction of refrigerants. The commenter continued that regulating at the point of sale would make implementing reclaim requirements easier, reduce the number of companies that EPA would have to regulate, and allow for more effective communication and collaboration between EPA and the regulated entities. The commenter further noted 14 companies control 89% of the consumption allowances and that eight of these 14 are reclaimers themselves, reducing the need for new infrastructure and investment. The commenter argued that this approach would also reduce the burden on small businesses.

Response: EPA disagrees with the commenter both on the small business impacts associated with recovering refrigerant and with how those impacts would be affected by the reclamation provisions. The Agency conducted a small business screening analysis and refers readers to section VI. The commenter did not provide sufficient information to explain how these provisions would divert resources from core operations and stifle innovation of the value chain. EPA considered supply chain and logistics when drafting the rule, including projections of future refrigerant supply. Based on these projections, EPA decided that finalizing reclaim servicing requirements for the impacted sectors is feasible.

EPA responds to the commenter's suggestion to regulate reclaim at the producer/import level by noting that it is not clear to the Agency how such a regime would work in practice. The commenter provides information on the potential benefits of efficiency and a reduced number of regulated entities, but does not make clear statements how this program could work. The commenter states that existing framework under 40 CFR 84 could simplify to implementation for point of sale for the reclaim requirements. However, it is unclear how the majority of reclaimers who are not importers or who do not receive allowances would operate under such a program for the effective implementation of the requirements for reclaimed HFC refrigerants for servicing and/or repair of refrigerant-containing equipment in certain RACHP sectors.

Comment: One commenter stated that to purchase "reclaim materials" in the market, a company would need to be an EPA-certified reclaimer, have reporting responsibility under EPA's HAWK (HFC and ODS Allowance Tracking)[96] electronic reporting system; demonstrate

[96] EPA's HAWK electronic reporting system can be accessed through the Electronic Greenhouse Gas Reporting Tool (e-GGRT). Regulated entities that are subject to reporting requirements under the AIM Act submit reports this electronic reporting system.

analytical chemistry and blending capabilities; avoid engaging in transshipping or various import schemes; demonstrate chain of custody ability; have a fleet of refillable cylinders; and maintain a physical reclamation facility in the United States. The commenter argued that a company should not be engaged in simply drop-shipping refrigerants to actual EPA-certified reclaimers to control access to the market. Similarly, no company involved in market manipulation or illegal imports should be allowed to grow market share by forcing small reclaimers out of the market and purchasing their allowances. Given the increased emphasis the proposed rule places on the role of EPA-certified reclaimers, the commenter recommended that EPA develop enhanced requirements for reviewing the qualifications of certified reclaimers. The commenter noted that this process should also include the inclusion of individuals on their Hotline who are not reclaimers but are buying material.

Response: EPA acknowledges this comment. EPA understands the term “reclaim materials” to refer to recovered materials that are available to be reclaimed. The Agency appreciates these considerations, but notes that we are not reopening nor modifying the criteria and qualifications for certification for reclaimers under 40 CFR part 82, subpart F in this rulemaking. EPA has established recordkeeping and reporting requirements for reclaimers under both the AIM Act and CAA section 608. In addition to these requirements, starting in 2024, EPA is requiring third party auditing of EPA certified reclaimers. Information related to the auditing of reclamation facilities can be found in 40 CFR 84.33.

Comment: One commenter recommended that EPA consider a mechanism that would allow negotiations between entities to fulfill reclaim requirements. The commenter stated that, for example, allowance holders of refrigerants, who may not want to manage reclaim operations or purchase reclaimed gas directly, could negotiate with another entity to take on CO_2 equivalent reclaim obligations, allowing smaller entities to participate in the reclaim program without significant investments in infrastructure or expertise. The commenter claimed that this would make the reclaim program more accessible and flexible for smaller allowance holders, promoting broader participation.

Response: EPA responds that EPA is not implementing a reclaim program based on CO_2 equivalency at this time. EPA notes that the established requirements in this rulemaking may result in some allowance holders purchasing reclaimed HFC refrigerants to service or repair their equipment in the covered RACHP subsectors; however, EPA does intend for all of these allowance holders to manage their own reclamation operations. Reclaimers, who in some cases are also allowance holders, are certified under 40 CFR 82.164. If an allowance holder who is not already a certified reclaimer wishes to manage their own reclamation operations, they would need to be approved by EPA to become a certified reclaimer.

The Agency understands the availability of advanced reclamation technology and describes some of these considerations in section IV.E.1, related to the reclamation standard. As EPA understands, some reclaimers have access to more advanced separation technologies to reprocess materials to proper specifications. These advanced technologies can be useful for reclaiming more complex and multi-component refrigerants blends. However, the Agency is establishing that reclaimed refrigerant may still contain an amount of virgin HFCs, that may be necessary for reclaiming these blends. Further, the Agency is not establishing requirements for the use of reclaimed HFCs in the initial fill of equipment in RACHP subsectors, where newer blends of refrigerants that are compliant with the 2023 Technology Transitions Rule would be used in new equipment. By limiting reclaim use requirements to servicing and repair, EPA is focusing on existing equipment where more common HFCs and HFC blends have been used for years and are currently being reclaimed.

Comment: One commenter recommended that EPA put a per pound deposit on regulated refrigerants that would be refunded when the substance is recycled. The commenter noted a potential downside due to the creation of a market for stolen refrigerant but noted that recordkeeping requirements would deter theft. The commenter suggested a balance between a price that could encourage recycling but not encourage theft and claimed that the cost would also support leak reduction measures. The commenter also recommended monthly reporting of refrigerants given the importance of the issue but also noted a negative impact on consumers as the cost of reporting increases. The commenter recommended relying on market forces where possible and providing rewards for compliance.

Response: EPA did not propose and is not finalizing refrigerant deposit program. If in the future, the Agency were to consider such a program, the Agency would evaluate the potential drawbacks of implementing such a program (such as the potential for fraud and increased recordkeeping or reporting burden) that could outweigh potential benefits. EPA notes that the requirements in the rulemaking have been established considering market conditions and other analyses as described in the RIA addendum for this rule.

Comment: Another commenter supported section 84.104(a) to prevent resale of reclaimed refrigerant for any purpose besides reclamation and recommended that there be explicit enforcement mechanisms, which the commenter requested EPA provide clearer guidance for what enforcement would entail under this rulemaking.

Response: EPA acknowledges this comment and notes that this provision is consistent with the statutory language in subsection (h)(2)(b) of the AIM Act, where recovered substances must be reclaimed before sold or transferred to a new owner, unless the recovered substances are being sold or transferred to a new owner solely for the purposes of reclamation or destruction. As described above, under 40 CFR part 82, subpart F, recovered refrigerant may be recycled and used for servicing or repair of the same appliance or another appliance of the same owner. EPA clarifies that this rulemaking does not prevent that practice.

EPA notes that the provisions related to reclaimed refrigerant use for servicing and/or repair of certain equipment build on the established reclamation standard for limiting the virgin HFC content in reclaimed refrigerant to 15 percent, by weight. This requirement, as described in section IV.E.1 includes labeling, recordkeeping, and certification requirements to ensure reclaimed refrigerants are meeting the established standard. Certification must be provided to the purchaser of the reclaimed refrigerants to verify that the product does not exceed the limit on virgin HFCs. Thus, the purchaser can ensure that reclaimed HFCs are appropriately used to service or repair equipment in the covered subsectors of this rulemaking. Enforcement action may be taken where virgin HFC refrigerant is used for servicing or repairing equipment in the covered subsectors, where containers of refrigerant do not have the proper labeling for reclaimed refrigerants and records/certifications can be checked. Specific requests about what more information is being asked for has not been described by the commenter, and the Agency may consider issuing additional guidance in the future.

Comment: One commenter argued that the proposed rule does not allow sufficient flexibility to spread reclaim across the entire market, allowing for potential circumvention in the aftermarket space. The commenter requested that EPA tailor reclaim requirements for sectors and end users to create a more flexible, practical, and achievable program. The commenter stated that reclaiming many newer refrigerants with HFO components is currently impractical and that

EPA should proceed on a CO_2e net basis to allow producers to provide more virgin lower-GWP substances and offset it with higher-GWP substances, in order to ensure both the transition to low-GWP alternatives and continued reclaim activity and encouraging the responsible transition to low-GWP refrigerants without hindering the overall effectiveness of the reclaim program, with requirements implemented at the producer or importer level to streamline AIM Act reporting.

The commenter further stated that companies should be encouraged to recover low-GWP refrigerants by receiving GWP credit towards compliance requirements, incentivizing low-GWP recovery. The commenter requested that EPA allow companies to voluntarily reclaim and place on the market refrigerants exceeding 2023 Technology Transitions thresholds beyond their percentage reclaim requirements and receive GWP credits. The commenter claimed that these two measures would encourage a consistent culture of refrigerant management across the industry, reward companies for reclaiming, and pave the way for future regulations. The commenter additionally proposed that EPA consider requiring that businesses or persons offering refrigerant for sale or distribution for service must receive recovered refrigerant for reclaim in a ratio determined and updated by the Administrator, preferably based on CO_2 equivalents. The commenter stated that, if implemented at the wholesaler/distributor level, this could be audited using the proposed container tracking system.

Response: EPA acknowledges the commenter's interest for flexibility and to spread the requirements to use reclaimed refrigerant across additional subsectors as well as their concerns for reclaiming blends with HFOs. As described above in section IV.E.1, EPA is establishing a limit of 15 percent, by weight, virgin HFCs in reclaimed HFC refrigerants. Further, EPA notes that we are not establishing a limit on the amount of virgin HFC substitutes that can be used in a reclaimed refrigerant blend and are thus not requiring reclamation of HFC substitutes. However, EPA recognizes that for HFC/HFO blends the commenter is likely referring to concerns with patents, licensing arrangements, and other business practices that may limit who can reclaim certain newer refrigerants. As discussed elsewhere in this final rule, the Agency is aware of these practices. However, the Agency has considered these concerns and made modifications to what it is finalizing in this rule that are intended to address these concerns. For example, EPA delayed the compliance date and narrowed the requirement for using reclaim and EPA is not finalizing requirements for the use of reclaimed HFCs for the initial fill of equipment in certain subsectors at this time. Existing equipment in the majority of cases currently use HFCs or HFC blends that are common and are currently being reclaimed.

The Agency did not propose and is not finalizing a crediting system. Moreover, the 2023 Technology Transitions Rule sets GWP limits for certain new equipment and not for existing equipment where this rule will require the use of reclaimed HFCs. The Agency is requiring the use of reclaimed HFCs for servicing of equipment in certain subsectors in the ER&R regulations established in this rulemaking. Moreover, EPA anticipates that there will be reclaimed refrigerant to meet demand for refrigerant servicing in the affected subsectors consistent with the compliance date, which may prevent the early retirement of existing equipment.

The Agency did not propose and is not finalizing refrigerant reclaim requirements on a CO_2e net basis. EPA acknowledges the comment on the use of a tracking system and notes that the Agency is not finalizing the proposed tracking system at this time.

Comment: One commenter stated that the supply of virgin refrigerants is far more plentiful than anticipated in 2021. The commenter stated that there seems to have been significant stockpiling, some amount of illegal imports, and significant growth in the import of products containing HFCs, with the value of imported air conditioning systems from Mexico increasing by approximately 50 percent from 2020 to 2022. The commenter noted that the allowance for Mexican refrigerant extends to R-410A containing condensing units, which may currently be imported with no restriction other than a label for service consistent with the 2023 Technology Transitions rule. The commenter stated that EPA could increase demand for reclaimed refrigerant by addressing this issue under the Technology Transitions Program. The commenter claimed that without these changes, it is unlikely that a transition away from R-410A will occur fully in the United States until 2034 when both countries are impacted by their phasedown schedules. The commenter also claimed that there will not be any significant demand for reclaimed refrigerant because of this legal allowance of imported products containing HFCs.

Response: EPA acknowledges these comments and concerns related to demand for reclaimed refrigerant due to the factors mentioned. EPA notes that this comment is out of scope for this rulemaking.

F. How is EPA establishing an HFC emissions reduction program for the fire suppression sector?

HFCs and substitutes for HFCs are used in many different sectors, subsectors, and applications beyond those in the RACHP sector, and EPA interprets its authority under subsection (h) to include promulgating regulations that control the types of practices, processes, or activities identified in subsection (h)(1) in those sectors, subsectors, and applications, with the limitation that we do not interpret our regulatory authority under subsection (h) to extend to HFCs or substitutes for HFCs when they are contained in foams.

HFCs are also used in the fire suppression sector. EPA is establishing certain requirements to address HFC management for fire suppression under subsection (h), further described in section IV.F.2. EPA proposed and is finalizing requirements for the use of recycled HFCs for the initial installation[97] and servicing and/or repair of fire suppression equipment as well as requirements for minimizing HFC releases during the servicing, repair, disposal, or installation of fire suppression equipment; technician training; recycling of HFCs prior to the disposal of fire suppression equipment containing HFCs; and recordkeeping and reporting. EPA is finalizing a compliance date of January 1, 2026, for the following fire suppression requirements: 1) minimizing HFC releases during the servicing, repair, disposal, or installation of fire suppression equipment; 2) the use of recycled HFCs for servicing and/or repair of fire suppression equipment; 3) technician training; 4) recycling of HFCs prior to the disposal of fire suppression equipment containing HFCs; and 5) recordkeeping and reporting. EPA is finalizing a compliance date of January 1, 2030, for the requirement to use recycled HFCs for the initial installation of fire suppression equipment.

EPA notes that the finalized definition of "fire suppression equipment" for purposes of subsection (h) excludes military equipment used in deployable and expeditionary applications, as well as space vehicles. Those applications are exempt from the requirements to use recycled HFCs in the installation, servicing and/or repair of such fire suppression equipment. This exclusion is based on EPA's understanding that there are situations in which the unique design and use of such military equipment and space vehicles make it impossible to recover fire suppression agents during the service, repair, disposal, or installation of the equipment. They are also exempt from the requirement to use recycled HFCs for the initial installation of equipment and for the servicing and/or repair of equipment.

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[97] EPA understands these terms "initial installation," "initial charge," or "initial fill" to be synonymous when discussing the use of recycled HFCs for fire suppression equipment.

Application-specific HFC allowances are available to mission-critical military end-uses as well as onboard aerospace fire suppression[98] applications under regulations at 40 CFR 84.13. EPA is not extending the requirement to use recycled HFCs in the installation, servicing and/or repair of such fire suppression equipment provided that they meet the requirements for application-specific allowances in 40 CFR 84.13. As long as they meet the requirements for application-specific allowances, these applications are also exempt from the requirement to use recycled HFCs for the initial installation of equipment and for the servicing and/or repair of equipment.

1. Nomenclature used in this section

This section uses the term "recycled" or "recycling" to describe the testing and/or reprocessing of HFCs used in the fire suppression sector to certain purity standards.[99] HFCs that are recycled for fire suppression use include HFC-227ea, HFC-125, HFC-236fa, and HFC-23. The term "recycled" or "recycling" as used in the fire suppression sector is similar, but not identical, to the term "reclaim" as defined under the AIM Act. Under the AIM Act, the terms "reclaim; reclamation" are defined in subsection (b)(9) of the Act, and that definition refers to the purity standards under AHRI Standard 700-2016 (or an appropriate successor standard adopted by the Administrator) and the verification of purity using, at a minimum, the analytical methodology described in that standard.

[98] Onboard aerospace fire suppression means use of a regulated substance in fire suppression equipment used on board commercial and general aviation aircraft, including commercial-derivative aircraft for military use; rotorcraft; and space vehicles.

[99] These industry standards may include NFPA 2001 (Standard on Clean Agent Fire Extinguishing Systems), NFPA 10 (Standard for Portable Fire Extinguishers), ASTM D6064-11 (Standard Specification for HFC-227ea), ASTM D6231/D6231M-21 (Standard Specification for HFC-125), ASTM D6541-21 (Standard Specification for HFC-236fa), and ASTM D6126/D6126M-21 (Standard Specification for HFC-23).

The fire suppression industry describes clean agent as "a gaseous fire suppressant that is electrically nonconducting and that does not leave a residue upon evaporation," and the term "clean agents" includes HFCs, according to the National Fire Protection Association (NFPA).[100] For the purposes of this section, EPA is generally referring to the term, "clean agents" as HFCs.

2. Emissions reduction in the fire suppression sector

As part of implementing subsection (h)(1), EPA is finalizing a number of requirements to minimize releases of HFCs during the servicing, repair, disposal, or installation of fire suppression equipment containing HFCs or during the use of such equipment for fire suppression technician training. These requirements are similar to the halon emissions reduction requirements found at 40 CFR part 82, subpart H. The fact that recycled halons have been the only supply of halons in the United States 30 years after its production and consumption phaseout in 1994 demonstrates the important role recovery and recycling of fire suppression clean agents can play by providing an ongoing supply where substitutes may not be suitable. As discussed in the proposal, EPA understands that this model has carried over on a voluntary basis to the management of HFCs by many in the fire suppression sector.

a. Minimizing releases of HFCs

To minimize releases of HFCs, EPA is requiring that covered entities installing, servicing, repairing, or disposing of fire suppression equipment containing a regulated substance may not release into the environment, such as by intentional venting, any HFCs used in such equipment. EPA also is requiring that owners and operators of fire suppression equipment

[100] National Fire Protection Association, NFPA Today, May 6, 2022, *https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2022/05/06/Clean-Agent-System-Basics*.

containing HFCs may not allow for the release of HFCs as a result of failure to maintain such equipment.

Recognizing the extensive requirements for testing (*e.g.*, Federal Aviation Administration, United States Coast Guard, Department of Defense) associated with the approval for use of fire suppressants in certain applications, certain limited HFC releases for health, safety, environmental, and other considerations are exempted, including:

- Releases during the testing of fire suppression equipment only if the following four criteria are met: 1) equipment employing suitable alternative fire suppression agents are not available, 2) release of fire suppression agent is essential to demonstrate equipment functionality, 3) failure of the equipment would pose great risk to human safety or the environment, and 4) a simulant agent cannot be used in place of the regulated substance for testing purposes.
- Releases associated with qualification and development testing during the design and development of equipment containing regulated substances only when 1) such tests are essential to demonstrate equipment functionality, and 2) a suitable simulant agent cannot be used in place of the regulated substance for testing purposes.

In addition, these requirements to minimize HFC releases do not apply to emergency releases of HFCs for actual fire extinguishing, explosion inertion, or other emergency applications for which the equipment were designed.

Below, EPA is responding to comments related to its approach and requirements to minimize releases of HFCs from the fire suppression sector.

Comment: Several commenters expressed support for the requirements to reduce HFC emissions from the fire suppression sector. One of the commenters stated that the proposed requirements are akin to the 1998 halon emissions reduction requirements. The commenter stated fire suppression sector has developed several voluntary measures to decrease emissions, such as the voluntary code of practice (VCOP) and the voluntary recycling code of practice (RCOP), and that these voluntary programs and the industry's experience in recycling halons provide the infrastructure necessary for the success of the HFC recycling requirements in EPA's proposal. The commenter also maintained that the required use of recycled HFCs is important in mitigating emissions and encouraging the use of other alternatives due to the high-GWP HFCs typically used in the fire suppression sector. Another commenter stated that the fire suppression industry fully supports EPA's goals of minimizing emissions of HFCs and encouraging the recycling and reuse of HFCs. The commenter stated that as a companion to the voluntary code of practice, an HFC emissions estimating program (HEEP) was developed that collects data on sales of HFCs for recharge of fire protection equipment as a surrogate for emissions. The commenter stated that compiled data of estimated emissions of HFCs from fire protection equipment have been submitted to EPA and published each year since 2002. Another commenter generally supported exploring potential practices that can help expand HFC recycling and reduce GHG emissions, while expressing concern with whether there is a sufficient supply of recycled HFCs for use in fire suppression systems.

A couple of commenters stated that the proposed requirements of 40 CFR 84.110(a), (b), (d), (e), and (f) are similar to the halon emission reduction requirements found at 40 CFR part 82, subpart H. One of the commenters stated that the halon emission reduction requirements have proven to be effective and useful in the responsible management of fire suppression agents and that these practices are commonplace in the fire protection industry and are incorporated into industry codes and standards. Another commenter commended EPA for basing the requirements for HFC management in fire suppression equipment on the halon emission reduction rule, as these practices are commonplace within the fire protection industry and incorporated into industry codes and standards. The commenter expressed support for the prohibition in 40 CFR 84.110(a) against knowingly venting HFCs in the installation, servicing, repair or disposal of fire suppression equipment. The commenter stated that the proposed exemptions for testing fire suppression equipment and qualification testing during system design and development are appropriate. The commenter also expressed support for the prohibition in section 84.110(b) against allowing release of HFCs as a result of failure to properly maintain equipment.

Response: EPA acknowledges the commenters' general support of the fire suppression requirements, and that the Agency considered the fire suppression industry's past experience with recycled halons as well as their voluntary efforts with recycled HFCs to develop fire suppression requirements that complement current industry practices to minimize emissions of HFCs.

Comment: A commenter recommended a stricter set of terms and greater consistency in alignment between industry groups represented in subsection (h), including the fire suppression industry and the RACHP industry. The commenter expressed support for the proposal to align requirements for recyclers of fire suppression or refrigerant-based systems to meet the same rigid standards as EPA 608 certified reclaimer program. The commenter maintained that voluntary practices do not require the level of recycling, such as the need for reclaim, so recycled HFCs sourced from fire suppression applications "could act to undermine the integrity and quality of the refrigerant supply chain." The commenter stated that the marketplace should be able to expect the same quality, rigor and tracking as proposed for refrigerants in the rulemaking.

Response: The Agency considers the fire suppression sector and the RACHP sector as distinct sectors with unique specifications and experiences, thus the requirements established for each sector are tailored to that sector. EPA understands that entities in the U.S. fire suppression industry typically operate in accordance with requirements from NFPA 2001 or NFPA 10 or appropriate American Society for Testing and Materials (ASTM) standards to recover and recycle HFCs during servicing and/or repair of fire suppression equipment. None of these current industry standards or specifications related to HFCs used in fire suppression contain specific requirements to minimize releases of HFCs, including during servicing or repair of the equipment. Therefore, and as noted by the commenter, efforts by the industry to minimize emissions of HFCs used in the fire suppression sector have to date been on a voluntary basis. For example, the VCOP includes as part of its emission reduction strategies during storage, handling, and transfer of HFCs to recover and recycle agents during servicing and to adopt maintenance practices that reduce leakage as much as is technically feasible. By adopting regulatory requirements informed by these current voluntary practices and relevant industry standards, this action will minimize emissions of HFCs more broadly within this sector of where HFCs are used, consistent with the purposes identified in subsection (h), and in a manner that maintains the integrity of recycled HFCs from this source.

b. Requirements for initial installation of equipment for fire suppression

EPA is requiring that for the fire suppression sector where HFCs are used, the initial installation of fire suppression equipment, including both total flooding systems and streaming applications, must be with recycled HFCs, starting on January 1, 2030. Specifically, for factory-charged equipment that use HFCs, EPA is requiring that in order to install such equipment, the equipment is required to use recycled HFCs for the initial installation during the manufacture of the equipment. These requirements apply whether the HFCs are used neat or in a blend. However, EPA notes that most often, where fire suppression agents are needed and HFCs are being used, these are single component HFCs with some of the highest GWPs for the regulated HFCs. Given the high GWPs for the commonly used HFC fire suppression agents, this aspect of the action is anticipated to further minimize emissions by requiring that recycled HFCs be used for the initial installation of fire suppression equipment.

Currently, recycled HFCs are primarily used for the servicing and recharge of existing fire suppression equipment. EPA understands that, in practice, recycled HFCs are required to meet applicable purity standards and function the same as their virgin counterparts when used in equipment in the fire suppression sector.

Comment: One commenter expressed support for EPA's proposal to increase the use of reclaimed and recycled HFCs in new and existing HFC containing fire suppression equipment. Some commenters expressed concern with the requirement to use recycled HFCs for the initial installation of fire suppression equipment. One of these commenters stated that the requirement to use recycled HFCs for first fill of fire suppression equipment should not be included in the final rule. The commenter also stated that there is uncertainty in whether the supply of recycled HFCs will be adequate to serve new and existing equipment. The commenter questioned the appropriateness and necessity of the requirement to use recycled HFCs for initial fill of fire suppression equipment. Additionally, the commenter stated that during meetings with EPA staff and in the public stakeholder meeting, no indication was given that initial fill of equipment would be regulated in this rule as the commenter understood that the technology transition section of the AIM Act was the appropriate place for such proposed regulations.

Another commenter stated that the proposed requirement to use only recycled HFCs for initial fill is not supported based on the historical success of halon recycling. The commenter stated that the current market for clean agent fire systems and the need for virgin HFCs is very different than the historical halon market. The commenter stated that they are a contributor to this success and suggested that EPA should not equate the current HFC market with that of halon given important differences between halons and HFCs and their use patterns. Specifically, the commenter stated that recycled halon has been made available for redeployment by a steady system of replacement with HFCs on a comparable performance basis, while current non-HFC replacement fire technologies provide many challenges to comparable replacement, extending the lifetime for HFC fire systems to remain in place, and reducing the availability of material to be recycled. The commenter also maintained that installed halon systems are significantly older than HFC systems, and that the accelerated changes in facilities and technologies being protected make many of these halon installations obsolete, providing sufficient stocks for recycling. The commenter provided an example that shipbreaking of aged vessels is a significant halon source for which there is no HFC equivalent. Additionally, the commenter stated that halon recovery and recycling is active and viable on a global basis and the United States receives significant quantities of halon from non-domestic sources, while non-domestic HFCs for recycling will require AIM Act allowances limiting their viability to relocate to the U.S. market, requiring a domestic installed HFC bank to support requirements for both service and new systems. However, the commenter stated that most installed HFC fire systems are protecting viable ongoing facilities with no anticipated need to convert or retrofit to alternate technologies, reducing the available resource bank.

Response: In response to the comment's assertions that there was no notice in public meetings of an intent to cover initial fill or installation, EPA notes that the proposed rule provided notification of our intention to include both initial installation and servicing requirements (88 FR 72216, October 19, 2023). EPA disagrees with the commenter's assertion that it should not draw parallels the experience with recycled halons with recycled HFCs. There are numerous similarities between the use of halons and the use of HFCs for fire suppression. This includes the supply chain, the types of applications and equipment, and general industry practices. Recycled halon is still available today, 30 years after the United States phased out production and consumption of halons. It is this experience since the phaseout of the halons in 1994 that demonstrates the important role recovery and recycling of fire suppression agents can play by providing an ongoing supply of HFCs in fire suppression applications especially where other substitutes may not be suitable. EPA understands that this model has carried over on a voluntary basis to the management of HFCs by many in the fire suppression sector.

In response to the comments questioning the appropriateness and necessity of the requirement to use recycled HFCs for initial installation of fire suppression equipment, EPA views the requirement to use of recycled HFCs for the initial installation of fire suppression equipment as part of its efforts to minimize emissions of HFCs from equipment, consistent with one of the purposes identified in the Act for regulations under subsection (h). EPA notes that most often, where fire suppression agents are needed and HFCs are being used, these are single component HFCs with some of the highest GWPs for the regulated HFCs. Given the high GWPs for the commonly used HFC fire suppression agents, this provision will further minimize emissions by requiring that only recycled HFCs be used in fire suppression equipment as well as ensuring that HFCs have been recovered and recycled from the equipment prior to the final step of the disposal of the equipment so that HFCs are not released during the disposal of the equipment. EPA understands that, in practice, recycled HFCs are required to meet applicable purity standards and function the same as their virgin counterparts when used in equipment in the fire suppression sector. Currently, recycled HFCs are primarily used for the servicing and recharge of existing fire suppression equipment. Halon Alternatives Research Corporation (HARC) comments on the October 2022 NODA indicate that it does not anticipate major barriers to using recycled HFCs in new fire suppression equipment. EPA understands while there may not be barriers to using recycled HFCs in new fire suppression equipment, commenters have stated that there may be uncertainty in the supply of recycled HFCs. EPA acknowledges that the need for allowances to import recycled HFCs for fire suppression, however we anticipate that as the HFC Phasedown progresses, HFCs no longer needed in larger uses such as refrigeration and air conditioning may become available for fire suppression applications. Informed by comments, EPA acknowledges that commenters expressed concerns regarding the supply of recycled HFCs and is extending the compliance dates for the use of recycled HFCs to ensure that the infrastructure and supply will be available for affected stakeholders to be able to comply with requirements, further described later in this section IV.F.2.b of this preamble.

With regards to the sourcing of used HFCs, the comments concerning the need for allowances is outside the scope of this rulemaking. In this section IV.F.2.b of the final rule, also see the comments regarding RACA process, which are beyond the scope of this action and thus require no further response because EPA has proposed no changes to the RACA requirements of process.

Comment: One commenter stated that their support for the AIM Act was based on there being a phasedown of HFC production, not a complete phaseout. The commenter stated that

EPA's proposal is equivalent to an HFC phaseout for fire protection in the United States, stating that they did not believe that it was appropriate or necessary for EPA to regulate initial fill of fire suppression equipment in this rule. The commenter also stated that it would put HFCs domestically in a more restrictive position than halons and CFCs, as these chemicals can be imported without the expenditure of allowances. In addition, the commenter stated that due to the high-GWP nature of HFCs used for fire protection, the observed effect of the AIM Act has been to reduce the production and consumption of virgin HFCs in the sector, below the phasedown schedule, and that companies have obtained the required listings and approvals so that a transition to the use of recycled HFCs in new fire suppression systems is underway. The commenter expressed a view that they would expect this transition to occur naturally and expand as the phasedown proceeds and argued that it was not environmentally justified to force this transition on the industry by regulation in what is in their view a short time frame.

Another commenter asserted that the proposed requirements for use of recycled HFCs for initial fill and recharge, would, in effect, ban the production of fire suppression HFCs as of January 1, 2025, and it would mean there would be no commercial market for virgin fire suppression HFCs, since any use of the agents (other than in extremely limited essential uses) would be illegal. The commentor contended that the AIM Act implements the phasedown under the Kigali Amendment to the Montreal Protocol and does not authorize EPA to issue a rule that results in a total ban on the production and consumption of HFCs, including fire suppression HFCs, and therefore that the proposed rule is not authorized by the AIM Act.

This commenter also stated that the proposed rule also violates the accelerated schedule provision of the AIM Act (42 U.S.C. § 7675(f)). This commenter maintained that the proposed fire suppression requirements would result in a total ban on the production and consumption of virgin fire suppression HFCs as of January 1, 2025, which would be more stringent than the phasedown schedule under subsection (e)(2)(C) of the AIM Act. Thus, they argued that establishing an effective total ban on the production and consumption of virgin fire suppression HFCs as of that date would require rulemaking following receipt of a petition as specified in subsection (f) of the AIM Act. The commentor also argued that the proposed requirement to use only recycled HFCs for initial fill is not supported based on the historical success of halon recycling, due to important differences between halons and HFCs and their use patterns. For example, the commentor stated an important difference between HFCs and halons is their relative firefighting effectiveness. The commenter stated that halons, bearing no blanket import restrictions, were successfully funneled into in reuse under a production phaseout due to halon's uniquely effective fire extinguishing properties. The commenter further stated that market forces in critical applications like aerospace consistently supported a recycle market, maintaining sufficient value to drive recycling activity. The commentor maintained that HFCs do not have the same level of market pull to support recycling activity in a market which immediately accelerates the sunset of virgin material for initial fill versus the anticipated phasedown schedule supported by the AIM Act framework rule.

Response: EPA disagrees with the commenters' assertion that finalizing these requirements under subsection (h) regarding the use of recycled fire suppression agents is a phaseout of HFCs or an acceleration of the phasedown under subsection (f) of the AIM Act. EPA further disagrees with the commenters' conclusion that these requirements are not authorized under the AIM Act.

While the AIM Act includes provisions related to the phasedown of production and consumption of HFCs, including the provisions in subsections (e) and (f) of the Act, it also includes separate and additional regulatory authorities, such as those in subsection (h) of the Act. As explained in detail throughout this notice, this rule is promulgated under subsection (h) of the Act, not subsections (e) or (f). Subsection (h) uses different language from subsections (e) and (f), and it is framed differently from them. EPA interprets Congress' direction under these subsections as different and as providing distinct authorities that are tailored to the respective areas of focus of these subsections, so that EPA can establish regulatory regimes that effectively achieve each subsection's purposes. For example, subsection (e)(1)(A) directs EPA to establish production and consumption baselines "for all regulated substances in the United States," and subsection (e)(2)(B) describes the methodology for determining the quantity of regulated substances that may be "produced or consumed in the United States" in a particular calendar year by multiplying the percentage listed for that year in subsection (e)(2)(C) by the production or consumption baseline. EPA's implementing regulations for these provisions establish limits on the "[t]otal production and consumption of regulated substances in the United States in each year," 40 CFR 84.7, that apply to HFC production and consumption in the United States on an economy-wide basis. Subsection (f) addresses EPA Administrator's authority to "promulgate regulations that establish a schedule for phasing down the production or consumption of regulated substances that is more stringent than the production and consumption levels of regulated substances required under subsection (e)(2)(C)" and the requirements for such regulations. The comment does not provide any data or analysis that indicates that the requirements to use recycled fire suppression agents in this rule would alter the phase down schedule established under subsection (e)(2)(C). EPA codified numeric levels of permissible production and consumption in 40 CFR 84.7(b)(3), Table 2. EPA did not propose and is not taking any action in this rulemaking that would change the economy-wide phasedown schedule established in subsection (e)(2)(C) or the numeric levels of permissible production and consumption codified in 40 CFR 84.7(b).[101] The production and consumption phasedown is implemented on an exchange value-weighted basis (rather than establishing caps for particular HFCs), and this rule does not alter the amount of HFC production and consumption allowed in any year on an exchange value-weighted basis, nor does it alter the number of allowances that EPA will allocate in a future year. Further, it does not prohibit any production or import of any HFC. HFCs affected by the rule's requirements to use recycled fire suppression agent are not exclusively used for fire suppression.

In contrast to the focus on the phasedown of production and consumption in subsections (e) and (f), subsection (h) is targeted at management of regulated substances. As relevant here, subsection (h)(1) directs EPA to "promulgate regulations to control, where appropriate, any practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment" that involves a regulated substance, for purposes that include minimizing releases of HFCs from equipment. This final action is an appropriate use of EPA's authority under subsection (h), as requiring the use of recycled HFCs to service, repair and install fire suppression equipment at a set date in the future is exactly the type of activity that the AIM Act envisions in subsection (h) since the requirements are controlling practices, processes, and activities regarding the servicing, repair, disposal, and installation of fire suppression equipment that involves a regulated substance.

[101] As this rule does not prohibit any production or consumption of HFCs, EPA need not and is not further addressing the comment's assertion that the AIM Act does not authorize EPA to issue a rule that results in a total ban on the production and consumption of HFCs, including fire suppression HFCs.

To the extent these commenters contend that these requirements would in effect ban the production or consumption of fire suppression HFCs, that is a mischaracterization of the requirements of the rule. These requirements require the practice or activity of using recycled HFCs to service, repair and install fire suppression equipment, with different compliance dates for existing and new equipment, and thus also control the practice or activity of using of virgin HFCs during these activities in fire suppression equipment. However, even if the requirements result in virgin HFCs no longer being used to service, repair and install fire suppression equipment, that is not a ban on production or consumption of HFCs, as those are distinct defined terms under the AIM Act. Requiring this practice or activity is appropriate under subsection (h). There is availability of recovered and reprocessed HFCs that can be used for this purpose. While opposing the time frame the proposed rule, one comment indicated that the transition to recycled HFCs in fire suppression is underway and would expand as the phasedown proceeds. Further, this provision will foster additional recycling of these HFCs and thus fewer emissions of HFCs from this equipment, consistent with the purposes identified in subsection (h).

EPA acknowledges that while there are numerous similarities, there may be certain market and efficacy differences between halons and HFCs. Since 1994, with the phaseout of the production and consumption of halons, recycled halons have been available and are still available today, which demonstrates the important role recovery and recycling of fire suppression agents can play by providing an ongoing supply of HFCs in fire suppression applications especially where substitutes may not be suitable. As discussed in the proposal, EPA understands that this model has already been carried over on a voluntary basis to the management of HFCs by many in the fire suppression sector. In 2002, the fire suppression industry developed a VCOP for the reduction of emissions of fire suppression agents including

HFCs. The VCOP was developed by the HARC, an industry organization, in partnership with EPA, the Fire Suppression Systems Association (FSSA), the Fire Equipment Manufacturers Association (FEMA), and the National Association of Fire Equipment Distributors (NAFED). Many of the practices have been already voluntarily adopted by the fire suppression sector, such as equipment manufacturers or distributors. In EPA's view, the fire suppression requirements will benefit from and bolster these efforts. While EPA notes that the commenter did not think HFC extinguishants would have the same market demand that supports halon recycling, the Agency views VCOP as example of this industry already significantly supporting HFC recycling and reuse of fire suppression agents and understands that with the extended compliance dates, it would provide the market time to adjust. EPA acknowledges that HFCs are not used in all the same applications as halons for various reasons and that for the near term those applications will continue to rely on the over 30-year practice of recycling and reusing halons. EPA considers the longstanding and highly successful use of recycled halons for both new and servicing of fire suppression agents in the United States to be a premier example of the effectiveness of relying on recycling.

The Agency responds to the comments regarding the compliance timelines to meet these requirements by noting EPA is finalizing compliance dates for the use of recycled HFCs for the initial installation (beginning January 1, 2030) and for servicing and/or repair (beginning January 1, 2026) of fire suppression equipment, as described in more detail in IV.F.2.b and IV.F.2.c.

Comment: One commenter mentioned that the final rule should preserve the ability to use substitutes for initial installation and servicing/repair of fire suppression equipment. The commenter stated that the proposed regulatory language could be read to suggest that only recycled regulated substances, and not their substitutes, could be used to fill and/or service fire suppression equipment. The commenter stated that this result was likely unintended because it overlooks the potential use of HFC substitutes in fire suppression equipment, which in some cases may more environmentally friendly than recycled HFCs. The commenter requested that EPA amend section 84.110(c) to clarify that fire suppression equipment must be initially charged and serviced with recycled HFCs or allowable HFC substitutes, as such substitutes become available on the market.

Response: EPA did not propose and is not finalizing requirements for the use of recycled HFC substitutes in fire suppression equipment at this time. EPA notes nothing in this final rule impedes the use of fire suppression alternatives. EPA determined it is prudent to limit the requirements to HFCs, noting the consumption and production phasedown will create scarcity for certain HFCs and such demand should partly be addressed by increased use of recycled HFCs. The Agency acknowledges the importance of HFC substitutes. The Agency encourages the development and deployment of HFC substitutes to the extent possible. EPA also recognizes in the context of a phasedown, there will be certain continuing uses of HFCs indefinitely.

Comment: A commenter mentioned that because the Federal Aviation Act and controlling case law interpreting the Act reserve to the FAA primary jurisdiction over matters related to aircraft safety and operations, requirements related to passenger aircraft air conditioning and fire suppression equipment necessarily falls within the purview of FAA's authority and therefore cannot be infringed upon by EPA. The commenter also states that more important than any jurisdictional considerations, any acknowledged threat to passenger safety is unacceptable as a regulatory requirement, and notes that a lack of meaningful coordination with the FAA could result in a failure to ensure that air safety is the top consideration when determining applicability of the proposed rule's requirements to the commercial aviation sector.

The commenter expressed support for EPA's proposed exemption for onboard aerospace fire suppression systems from the requirement to use recycled HFCs and recommended that the exemption be expanded to hangar fire suppression systems. The commenter also requested the broadest application possible for this proposed exemption given the potentially lengthy process for FAA approval of such products and their potential to impact the safe operation of aircraft.

The commenter stated that the proposed rule does not appear to contain a similar exemption from the requirement to use recycled HFCs for fire suppression systems in hangars. The commenter stated that hangar fire suppression systems are highly specialized, and mandating that new and existing hangar fire suppression systems use recycled HFCs could be incredibly costly for their members and potentially disruptive to safe and smooth commercial aviation operations. The commenter also stated that such a requirement for hangars must also go through the FAA consultation process to ensure that any final requirements that may apply to the commercial aviation sector and its ground facilities do not jeopardize safety or the smooth and efficient operation of the commercial aviation industry when planes are in the air and on the ground.

Response: EPA disagrees with the commenter's broad assertions that EPA does not have authority to issue regulations pertaining to HFCs in aircraft and aircraft operations. While EPA agrees that the FAA has jurisdiction over matters related to aircraft safety and operations consistent with its Congressionally mandated authorities, under CAA Title VI and the AIM Act, EPA has issued numerous regulations that concern the use of ODS and HFCs in many applications including onboard aviation and flight operations. With respect to this action, the AIM Act does not exclude aircraft or aircraft operations from the scope of implementing regulations. Notably, the inclusion in the statute at (e)(4)(b)(iv)(ff) of "onboard aerospace fire suppression," which includes aircraft, indicates that Congress did not intent to exempt aircraft and aircraft operations from the AIM Act. In addition, the commenter does not address the provisions of subsection (h) itself. None of the text of subsection (h) indicates that Congress contemplated that these provisions would not apply to equipment used in commercial aviation. Congress expressly addressed inapplicability of regulations under (h) in subsection (h)(4), in which it provided that regulations under subsection (h) shall not apply to HFCs or their substitutes contained in foams. If Congress had intended to exclude equipment used in commercial aviation from regulations promulgated under subsection (h), it would be reasonable to expect that the statute would include similar language creating that exclusion. Although the comments do not appear to base their objections on the text of subsection (h), to the extent they intend to argue that this rulemaking exceeds EPA's authority under that provision, EPA notes that it is establishing the subsection (h) requirements in this final action to control practices, processes, or activities regarding the servicing, repair, disposal, or installation of equipment that involves a regulated substance or a substitute for a regulated substance and to serve the statutory purposes identified in subsection (h). Thus, this final action is within the scope of EPA's authority under subsection (h)(1), including as it pertains to equipment used in commercial aviation. Further, as discussed above, EPA in not extending the requirements for use of recycled HFCs to onboard aerospace fire suppression applications already under finalized EPA regulations at 40 CFR 84.13.

With respect the commenters' assertions that finalizing the proposed rule would conflict with the Federal Aviation Act's statutory purpose and scheme and that this statute reserves to the FAA jurisdiction over matters related to aircraft safety and operations and broadly preempts the field of regulation with respect to commercial aviation, aircraft operations, and aircraft safety, EPA responds that the information presented in the comment letter does not indicate that EPA is generally precluded from including requirements related to the commercial aviation sector in this rulemaking. The comment cites and quotes cases that speak to the pervasive nature of federal regulation in this area and address the preemption of state and local regulations. However, preemption of state and local laws is not relevant to EPA's authority to establish regulations.

In response to the commenter's assertions that EPA should consult with the FAA on these regulations, the Agency communicated with the FAA as we have communicated with other federal agencies to better inform our rulemaking under the AIM Act.

EPA also disagrees with the commenter that hangars or ground facilities are not subject to this rule and should be exempted. EPA is not requiring the use of HFCs for the initial installation or servicing and/or repair of fire suppression equipment in certain applications that receive application-specific allowances, including mission-critical military end uses and onboard aerospace fire suppression. Onboard aerospace fire suppression is one of the six applications listed in the AIM Act that allows companies that use HFCs to receive application-specific allowances. Specifically, as defined in EPA's implementing regulations at 40 CFR 84.3, onboard aerospace fire suppression means use of a regulated substance in fire suppression equipment used aboard commercial and general aviation aircraft, including commercial-derivative aircraft for military use; rotorcraft; and space vehicles. Onboard commercial aviation fire suppression systems are installed throughout mainline and regional passenger and freighter aircraft, including engine nacelles, auxiliary power units (APUs), lavatory trash receptacles, baggage/crew compartments, and handheld extinguishers. As such, hangars or ground facilities do not fall under this purview.

Comment: The Agency also received comments regarding the supply of recycled HFCs. One commenter stated that while they mentioned that there are no barriers to using recycled HFCs for initial fill, they provide no information that could be used to conclude that the supply of recycled HFCs is adequate to serve new and existing equipment. The commenter also stated that their concern is not currently when the supply of recycled HFCs may be high, but five to ten years in the future as there may still be a significant installed base of HFC-containing equipment. Another commenter maintained that recycled HFCs have been used for years to recharge most fire systems in the event of discharge, and that historically the availability of recycled HFCs has balanced well with the nominal requirements for system service. The commenter stated that there are not sufficient recycled HFCs available to the market to confidently supply all domestic fire suppression needs for both service and new systems now and into the future. The commenter also stated that the lack of sufficient available fire suppressants to meet crucial fire suppression needs will put critical facilities, and the people who work in those facilities, at risk of harm from fire events and reduce market confidence in the use of fire suppression technologies for special hazard applications. The commenter also stated that the remaining need for HFCs in new systems in the United States is due to a lack of viable alternatives meeting very challenging technical requirements for special hazard fire systems. The commenter maintained that implementing the rule as proposed will make providing effective fire suppression more difficult for these applications without providing a meaningful impact on emissions associated with the use of HFCs in fire suppression.

Another commenter stated that while there is a robust recycling market in the fire suppression industry, there is concern that the availability of recycled HFCs would not always balance market demand under the proposed rule requirements. Instead, the commenter suggested that the availability of recycled HFCs would adjust to balance the required market needs given time under the current AIM Act rule structure. The commenter stated that the required use of recycled fire suppression agent would be unnecessary and counterproductive to the existing market-driven activities in the fire suppression industry.

One of the commenters expressed concern over whether the proposed requirements would ensure that there is a sufficient supply of recycled HFCs available for use in fire suppression systems, especially for hangars. The commenter stated that if EPA intends for hangars to be covered by the proposed fire suppression system requirements, it is imperative that the requirements ensure that a sufficient supply of recycled HFCs would be available so that industry sectors would have a sufficient supply of necessary materials to ensure safe operations while also complying with any applicable regulatory requirements.

Response: EPA acknowledges comments related to the supply of recycled HFCs to support the recycled HFC use requirements for fire suppression established in this rulemaking. EPA understands that the fire suppression industry has been generally using recycled HFCs for servicing (as shown in the HEEP data).

EPA acknowledges that the phasedown of production and consumption of HFCs under the AIM Act and Kigali Amendment to the Montreal Protocol will have broader impacts on HFC use and transition to HFC substitutes. In the context of the HFC phasedown, not establishing requirements to limit the release of HFCs will create supply issues as the phasedown progresses. As addressed elsewhere in this final rule, this final rule is being promulgated under subsection (h). EPA acknowledges the comments regarding the current market structure of the fire suppression industry with respect to the use of recycled HFCs. EPA notes that the provisions established in this rulemaking are intended to support increased recycling and further bolster the supply of recycled HFCs. As the phasedown progresses, other sectors that use certain HFCs may reduce their use of certain HFCs or no longer use certain HFCs, which may be become available for use in the fire suppression sector. After further consideration, EPA agrees that additional time is warranted as it should enable the fire suppression sector to build up additional stock of recycled HFCs to meet demand for the installation, servicing and/or repair of fire suppression equipment. The date for the use of recycled HFCs for the initial installation of fire suppression equipment is after the next major phasedown step of production and consumption of virgin HFCs under the AIM Act, when recycled HFCs will play an even greater role in supporting the servicing and repair of existing equipment. The commenters pointed to the need for additional time for the market to further adjust supply and demand for recycled fire suppression agents. Thus, EPA is finalizing later compliance dates than proposed for the use of recycled HFCs for the initial installation and the servicing and/or repair of fire suppression equipment, as described in more detail in sections IV.F.2.b and IV.F.2.c. The Agency also is finalizing differentiated dates for servicing and initial installation, with the date for servicing earlier than initial installation based on commenters' information on current practices.

Comment: One commenter stated the proposed requirement to only use recycled HFCs for initial fill will disrupt the current market driven balance of recycled agent supply and demand, impacting the AIM Act's important environmental goals. The commenter stated that the 2020 HEEP data shows recycled HFCs currently support the preponderance of system service requirements (80 percent in 2020), providing a viable and responsible life cycle process and market driven balance. The commenter claimed however the proposal requiring the use of recycled HFCs for initial installation would have the effect of reinforcing the market perception that HFCs are being regulated out of existence. The commenter stated that EU's 2000 regulation devalued halon 1301, and that the regulation correlated with the EU halon emissions. The commenter voiced concerns that the requirement to use only recycled HFCs for initial fill, by overriding current market forces, would have a similar effect of instigating a spike in emissions due to collapse of market confidence in HFCs. In such a market, the commenter maintained, where used HFC stocks are of low or negative value, owners and service entities could be negatively incentivized to release stocks of HFCs to the atmosphere in anticipation of further regulations or to avoid storing a valueless commodity. Additionally, the commenter also stated that with the termination of a potential fire suppression agent (*i.e.*, FK-5-1-12) production from a manufacturer, there may likely be insufficient supply of a low-GWP alternative for HFCs, causing uncertainty about the long-term viability of fire suppression technologies. The commenter further stated that, as with EU in 2000, they expected a rise in HFC emissions from the fire suppression sector if the requirement to use recycled HFCs for initial fill is promulgated. The commenter stated that the proposed rule, along with potential supply issues, would severely restrict market access to effective fire suppressants, further eroding customer confidence in clean agent protection and putting additional critical facilities and people at risk from a fire event.

Response: EPA disagrees with the commenter's assessment of the requirement for the use of recycled HFCs in the fire suppression sector as disruptive or that they would be misinterpreted as regulating HFCs out of existence. The AIM Act directs EPA to implement an 85 percent phasedown of the production and consumption of HFCs from baseline by 2036. This is a phasedown and not a phaseout. The Agency foresees continued production and consumption of HFCs beyond 2036 albeit limited so as to not exceed the very restrictive cap. While this final rule has the effect of restricting the use of virgin HFCs for particular practices, processes and activities related to servicing, repair, and installation of particular equipment, those requirements do not apply to all applications in which HFCs are used and they do not limit the use of recycled or reclaimed HFCs that meet the regulatory criteria. In fact, as discussed throughout this final rule, the Agency expects virgin production and consumption consistent with 40 CFR part 84, subpart A will continue, and anticipates continued use of both virgin and reclaimed or recycled HFCs. Consistent with subsection (h), in developing this rule the Agency explored options that would serve the purposes identified in subsection (h)(1), including of minimizing emissions of HFCs from equipment and maximizing reclamation where appropriate. The Agency considers fire suppression, with its long and successful history of using recycled HFCs as an appropriate application for this requirement. As the phasedown continues, the availability of virgin HFCs decreases while increasing market demand for recycled HFCs in the fire suppression sector; however, EPA anticipates there will be continued demand for and use of virgin HFCs for other applications for many years. Unlike halons, most of the HFCs used in fire suppression have other uses (*e.g.*, HFC-227ea is used as a propellant for metered dose inhalers). Halons generally have only been used for fire suppression. As market demand increases for recycled HFCs in the fire suppression sector, the value of the recycled HFCs should also increase and leading to more incentive to recover and recycle HFCs rather than releasing them. As one commenter stated that recycled HFCs support many service requirements, providing a viable and responsible life cycle process and market driven balance, EPA views the requirements to use recycled HFCs in fire suppression equipment to bolster this effort.

Comment: EPA received comments requesting the export of fire suppression systems containing virgin HFCs. One commenter interpreted the phrase “that is installed in the United States” in 84.110(c), to say that the requirement to use recycled HFCs for initial fill of fire suppression equipment does not pertain to equipment intended for export. The commenter stated that fire suppression equipment intended for export could continue to be installed with virgin HFCs and that the expended allowances would continue to be refunded under the RACA process. The commenter asked for confirmation on the interpretation in the final rule.

Another commenter asserted that with the implementation of the AIM Act, the volume of HFCs placed in new fire systems in the United States has dramatically decreased. The commenter experienced more than 90 percent reduction in volume of HFCs in new systems, far exceeding the intent and goals of the AIM Act. The commenter further stated that the AIM Act has motivated fire system manufacturers to promote non-HFCs alternatives and initiate approvals for recycled HFC use in new fire systems. The commenter stated that there is no reasonable requirement for EPA to overreach its authority and require the use of recycled HFCs in the fire market, and that the market is responding and progressing in an accelerated manner without prescriptive forces. The commenter further stated if EPA believes it has the authority under the AIM Act and there is a need and benefit to requiring the use of recycled HFCs for fire suppression equipment, both new systems and service, in the United States, the export of fire systems containing virgin HFCs should continue to be allowed and qualify for the RACA process. The commenter stated that requiring U.S. fire system manufacturers to use only recycled agents for all global requirements would place them at a significant competitive disadvantage and appreciably reduce the available inventories of domestic recycled HFC fire extinguishing agents.

Response: In response to this comment, EPA first notes that it views the requirement in this final rule for the use of recycled HFCs for fire suppression equipment to align with the purpose of minimizing the release of HFCs from that equipment under subsection (h) and to be consistent with its authority under that provision, as discussed in detail elsewhere in this section.[102] EPA notes that with certain limited exceptions discussed in section IV.F, fire suppression equipment installed in the United States will be required to meet the requirements the Agency is finalizing in this action. The comments regarding RACA are beyond the scope of this action and thus require no further response because EPA has proposed no changes to the RACA requirements of process. However, for purposes of providing information to regulated entities, EPA notes that whether fire suppression equipment may qualify for the RACA process depends on whether the equipment meets the definition of bulk in 40 CFR 84.3, which EPA is not reopening or revising through this rulemaking. For the purposes of 40 CFR part 84, subpart A, system cylinders, such as those used in total flooding systems are bulk substances and may be eligible for the RACA process. A portable fire extinguisher, in contrast, is not considered bulk regulated substance because it contains a dispensing apparatus and may be used without transferring the contained regulated substance to another container. These portable fire extinguishers are products and are not eligible for the RACA process. Furthermore, RACAs are not limited to virgin HFCs – additional consumption allowances may be requested in general for verified exports of any bulk regulated substance.

EPA proposed a compliance date of January 1, 2025, for the use of recycled HFCs in the initial installation of fire suppression equipment, and also considered other potential compliance

[102] The comment is not clear whether it intends to suggest that the commenter views these provisions as an overreach of EPA's authority or rather is simply stating that there would be no need to overreach EPA's authority in this context (without expressing any opinion as to whether the proposed provisions did so), the commenter fails to provide any reasoning or analysis that would support an argument that these provisions exceed EPA's authority and does not provide any explanation for why it disagrees with the discussion of authority for these provisions that EPA provided in the proposal. Accordingly, even if the comment does intend to challenge EPA's authority for the fire suppression provisions, those points are addressed by EPA's discussion of its authority elsewhere in this section and no further response is needed.

dates. In this final rule, the Agency sets a compliance date of January 1, 2030, for the use of recycled HFCs in the initial installation of fire suppression equipment.

Comment: One commenter stated that the compliance date of January 1, 2025, is feasible given the sector's overall comparatively small volumes of material, as well as existing infrastructure and practices regarding the use of reclaimed material, which already makes up a significant percentage of overall volumes. A few commenters expressed concern regarding the January 1, 2025, start date for the requirement for the use of recycled HFCs for the initial installation of fire suppression equipment.

One commenter stated that the time to implement the recycle requirement proposal is not sufficient for industry to adjust. The commenter stated that the proposed rule will likely leave stranded virgin HFCs already in the U.S. inventory, given the few alternative applications of fire suppression HFCs have for use in other market segments, and argued that the timeframe would damage responsible manufacturers and shake industry confidence in clean agent fire protection technologies. The commenter stated that the short enaction timeframe will create significant delays, contract disputes, and costly modifications for projects currently in process, since new fire system requirements are mostly for newly constructed facilities, fire systems are often the last item to be installed before occupancy, and construction agreements are executed in advance of the delivery of the specified fire system, with many subcontractor agreements. The commenter mentioned that this too will further destabilize and reduce confidence in the overall fire system industry and stall the current market driven shift to recycled HFCs and alternative protection options. Additionally, the commenter maintained that the fire suppression industry operates under existing long-term contracts that require commitments of certain volumes using specific agents and argued that the rule as proposed will cause problems and irreparable financial harm to business and users with these contractual obligations. The commenter stated that an alternative to the initial fill rule proposed, which is a ban on the import of virgin HFCs for use in domestic fire protection (except for the critical end-uses) after a certain future date, could be considered. The commenter stated that this may help avoid the irreparable financial harm to entities who have, since Sept. 23, 2021, acted in good faith under the framework rule. The commenter expressed concerns that the passage of the rule, with the recycled HFC initial fill requirement as proposed, will not reduce HFC emissions or improve the environmental impact of HFC fire systems to sufficiently offset the increased risk to property and people.

The same commenter claimed that EPA's 2025 enaction timeframe limits the ability to revise and adjust these agreements and would create confusion among entities who have entered into agreements in good faith under the AIM Act framework schedules and structures. The commenter stated that if EPA were to enact this requirement, they would recommend a start date of January 1, 2036, or after the point in time in which the AIM Act phasedown to 15 percent of baseline is complete, in order to allow equipment manufacturers to fulfill or modify existing contracts, and for potential low-GWP alternatives to be introduced in an orderly manner, supportive of the market balance the commenter maintains is necessary for a viable, long-term, recycled HFC market. The commenter stated that if EPA believes enactment of this a rule is required, an in-force date, no sooner than a 2030 through 2036 timeframe, must be considered to provide sufficient time to effectively prepare for such a ruling.

Another commenter requested that EPA extend the date of implementation to January 1, 2027, to allow proper time for fire suppression equipment manufacturers to assess any safety concerns or unexpected impacts of transitioning to recycled substances and development of the reclaimed HFC supply.

Another commenter stated that since the final rule will not be published until sometime in 2024, the industry would have less than a year to transition to using recycled HFCs for all first fills. The commenter stated that if EPA decides to maintain this requirement in the final rule, a start date of January 1, 2030, would be more appropriate. The commenter stated that this would provide time for equipment manufacturers to fulfill or modify existing contracts that specify newly produced agent and find alternative avenues of supply.

One commenter stated that the proposal provides a short window to perform the transition and in their view, the most logical year would be to start the transition in 2029 when the next stepdown happens. The commenter stated that the fire suppression industry is project-based and often, projects are worked in phases over many years.

One commenter stated that the proposal does not provide sufficient time for the commercial aviation sector to safely comply with the proposed fire suppression system requirements at ground facilities such as hangars. The commenter requested that EPA extend the applicable compliance deadlines for using recycled HFCs in fire suppression systems.

Response: EPA acknowledges these comments both in support of and raising concerns for the timing for the use of recycled HFCs including sufficient availability of recycled HFCs for the initial installation of fire suppression equipment. EPA acknowledges the importance of the overall HFC phasedown and notes that comments on the phasedown's structure, including a ban on the import of virgin HFCs for use in fire suppression and use of consumption allowances to import virgin HFCs, is beyond the scope of this action and require no further response. The Agency does not agree that the provisions in this final rule result in irreparable financial harm with an adjustment to the compliance date. As noted previously, reliance on recovered and reusable HFCs will be increasingly important. Informed by comments and after further evaluation, EPA is finalizing the compliance date for the use of recycled HFCs for the initial installation of fire suppression equipment of January 1, 2030, five years later than proposed and after the next phasedown in 2029. This will provide any companies using virgin HFCs for this purpose more time to transition to recycled HFCs. It will also allow industry time to adjust any relevant existing contracts concerning supply of recycled HFCs, and provide more time to alleviate concern with inadequate supply of recycled HFCs.

Comment: A couple commenters also mentioned that potential cross contamination continues be an issue for recycled halon and that the requirements in 40 CFR 84.110(c)(1) and (2) should support the avoidance of this issue for HFCs in the fire suppression sector. One of the commenters commended EPA for the requirements intended to prevent cross-contamination of recycled fire suppression agents during transfer, recovery, and storage, stating that the cross-contamination of recycled halon 1301 is an ongoing problem, and that these requirements would enhance ongoing industry efforts and keep it from becoming a significant issue for HFCs.

Response: EPA acknowledges the comments that the requirements in 40 CFR 84.110(c)(1) and (2) should help to address potential cross-contamination issues with HFCs used for fire suppression.

Comment: One commenter stated that EPA's proffered options for the use of recycled HFCs for initial fill still come with difficult challenges: how far out to extend the requirement to ensure sufficient available recycled material, how to report and manage a variable percent recycled content requirement. The commentor stated that existing AIM Act structure already puts a challenge to the use of virgin HFCs in fire suppression due to their high-GWP allowance opportunity cost. The commenter stated that this intent of the AIM Act is motivating industry towards low/no GWP options where available, promoting the general use of recycled material when possible, but leaving the flexibility of new virgin material for those applications requiring the performance and safety of an HFC fire suppression agent when low/no GWP options are suitable and recycled HFCs may be unavailable. The commenter suggested that this is the right way to manage the limited use of HFCs in fire suppression without putting critical facilities and people at risk of a fire.

Response: As described in the proposal, EPA sought comments from stakeholders on options that would be viable. The commenter does not cite any provision in the AIM Act to support its assertion that the Act's intent is to leave general flexibility to use new virgin material for fire suppression applications nor does it cite any information or data to support the implication that there are situations when performance and safety requirements would indicate use of an HFC fire suppressant but no low/no GWP options are suitable and recycled HFCs are unavailable. Thus, EPA cannot provide a more detailed response to these concerns. As explained in detail elsewhere in this notice (section IV.F.2.b of this preamble), the provisions finalized in this action, including the requirements to use recycled HFCs in fire suppression equipment are consistent with EPA's interpretation of its authority under subsection (h) of the Act and the direction in that statutory provision. Further, elsewhere in this notice (section IV.F.2.b of this preamble), EPA has made adjustments to the requirements in the final rule based on points raised in public comments by delaying the compliance dates to address possible concerns with the supply of recycle HFCs. To the extent this comment concerns aspects of the AIM Act or EPA's implementing regulations beyond the proposed rule under subsection (h) – such as the allowances, the structure of the phasedown, and tradeable allowances – it is outside the scope of this rulemaking. EPA has a long and successful history of working with the fire suppression industry to lead in the production phaseout of halons and transition to safe alternatives through testing and changes to industry standards. This has been taken into consideration the needs and challenges in sectors such as the military, oil and gas, maritime, and aviation to protect critical facilities, equipment, and personnel. We look forward to managing the ER&R program in the same way.

c. Requirements for servicing and/or repair of existing equipment for fire suppression

EPA is requiring the use of recycled HFCs for the servicing and/or repair of fire suppression equipment, including both total flooding systems and streaming applications, starting on January 1, 2026. Covered entities are required to evacuate, as applicable, all equipment used to recover, store, and transfer HFCs prior to each use to prevent contamination, arrange for destruction of the recovered HFCs as necessary (*e.g.*, recovered HFCs that are too contaminated to be recycled), and collect and dispose of wastes from recycling process. If the recycling of HFCs is not practical, the disposal of HFCs will help to prevent releases of used HFCs into the atmosphere.

In 2015, data on recycling of HFC fire suppression agents were collected as part of the HEEP, which is voluntary data collection effort implemented by the fire suppression industry. HEEP collects data on sales of fire suppression agents for recharge in order to estimate annual emissions of HFCs. These data showed that the HFC-227ea, HFC-125, HFC-236fa and HFC-23 are all recycled for fire suppression use.[103] In recent years, approximately 75 percent of HFCs sold for recharge came from recyclers, with 80 percent reported in 2020, based on data submitted voluntarily to HEEP and may not include all entities in this sector.[104]

[103] HARC comments on Notice of Data Availability Relevant to Management of Regulated Substances under the American Innovation and Manufacturing Act of 2020 are available in the docket (EPA-HQ-OAR-2022-0606) for this rulemaking at *https://www.regulations.gov*.
[104] HARC Report of the HFC Emissions Estimating Program (HEEP) 2002–2020 Data Collection, October 2022.

As part of servicing and/or repairing fire suppression equipment, recovery and recycling equipment is used to recover HFCs. EPA is also requiring that covered entities must 1) operate and maintain recovery and recycling equipment in accordance with manufacturer specifications to ensure that the equipment performs as specified; 2) repair leaks in HFC storage, recovery, recycling, or charging equipment before use; and 3) ensure that cross-contamination does not occur through the mixing of HFCs that may be contained in similar cylinders. Recovery equipment collect HFCs from equipment and recycling equipment remove contaminants from HFCs and this equipment is used during servicing and/or repair. By ensuring that this equipment is functioning properly, HFC releases can be minimized during the recovery and recycling process. The requirements will ensure that releases from fire suppression equipment are minimized when recycling HFCs during servicing and/or repairing fire suppression equipment.

Comment: One commenter stated that there is no need to require the fire industry to migrate to a recycled agent for servicing existing systems. The commenter stated that most important protected assets require quick servicing, often within 24 hours, in order to maintain their critical functions. The commenter stated that sometimes, to maintain critical function in a timely manner, newly made HFCs are more expedient. The commenter stated that the high value risk and critical function requirements of many protected facilities supports the continued availability of both options, virgin and recycled, to best manage risk for these facilities.

Another commenter mentioned that the AIM Act has already effectively reduced the use of HFCs in new fire suppression systems beyond the statutory requirements of the Act, reinforcing the use of recycled HFCs for servicing existing systems. This comment is also covered in section IV.F.2.b of this final rule

As mentioned in section IV.F.2.b of this final rule, one commenter expressed support for EPA's proposal to increase the use of reclaimed and recycled HFCs in new and existing HFC containing fire suppression equipment. Another commenter also expressed support for the proposal to require the use of recycled HFCs to service existing fire suppression equipment. The commenter stated that as the HEEP data shows, recycled HFCs already provide the vast majority of agent used for servicing in the United States. The commenter suggested that the requirement to use recycled HFCs for servicing should begin on January 1, 2028, in order to provide adequate time for any companies still using virgin HFCs for service to make the transition.

Response: As the HEEP data shows, recycled HFCs are already extensively being used for servicing. EPA understands this to be already industry practice used by most entities. EPA also appreciates the need for flexibility in supporting critical function of fire suppression equipment and in particular for high valued equipment. Therefore, EPA is finalizing a later compliance date than proposed for the use recycled HFCs in the service and/or repair of fire suppression equipment (*i.e.*, January 1, 2026) to provide industry time to adjust to the changes, make any necessary infrastructure changes and make any necessary changes to existing business contracts. This delay of the compliance date will enable the fire suppression industry to build up additional stock of recycled HFCs to meet demand for servicing and/or repair of fire suppression equipment. While one commenter suggested a compliance date of 2028 for servicing, EPA concludes that an earlier compliance date than 2028 is reasonable for these requirements, given the use of recycled HFCs is already common practice in the fire suppression industry for this application.

Comment: As covered in section IV.F.2.b of this final rule, one commenter mentioned that the final rule should preserve the ability to use substitutes for initial installation and servicing/repair of fire suppression equipment.

Response: As covered in section IV.F.2.b of this final rule, EPA acknowledges the comment. As responded to in section IV.F.2.b of this final rule, nothing in this final rule impedes the use of fire suppression alternatives.

d. Fire suppression technician training

Starting as of January 1, 2026, EPA is requiring that all entities that employ fire suppression technicians who maintain, service, repair, install, or dispose of fire suppression equipment containing HFCs must provide training (as described in this section) and ensure that their fire suppression technicians complete this training. Fire suppression technicians hired after that date must be similarly trained within 30 days of hiring. EPA considers this as a one-time training requirement. This requirement is intended to control practices, processes, or activities regarding servicing, repair, disposal, or installation of such fire suppression equipment by providing fire suppression technicians with knowledge and skills to minimize releases of HFCs during such practices, processes, or activities, and the requirements involve a regulated substance. Fire suppression technicians are an important part in any effort to control unnecessary HFC emissions from fire suppression equipment while servicing, repairing, installing, or disposing of such equipment. By training fire suppression technicians in the significance of minimizing unnecessary HFC releases from fire suppression equipment and providing information on applicable procedures such as the recovery and recycling or reclamation of HFCs from the fire suppression equipment, technician training supports EPA's effort to reduce HFC emissions from fire suppression equipment.

The HFC fire suppression technician training must be designed to cover: 1) an explanation of the purpose of the training requirement, including the significance of minimizing releases of HFCs and ensuring technician safety, 2) an overview of HFCs and environmental concerns with HFCs, 3) a review of relevant regulations concerning HFCs,[105] including the requirements of the HFC emissions reduction program for fire suppression equipment, and 4) specific technical instruction relevant to avoiding unnecessary HFC emissions during the servicing, repair, disposal, or installation of fire suppression equipment at each individual facility.

Comment: A few commenters expressed their support for EPA's proposed fire suppression technician training requirements. One of the commenters expressed support for the proposed training requirements for this sector to ensure higher rates of recovery and recycling of HFCs. The commenter stated that the proposed training requirements will be highly valuable to the fire suppression sector that has technicians skilled in the recovery and recycling of HFCs. Another commenter supported enhanced training for fire suppression technicians to facilitate the implementation of the fire protection requirements.

One commenter requested that EPA develop course content of the required training and make it available to the regulated community. The commenter stated that this would ensure consistent course content across the country and be far more cost-effective then having every regulated facility generate training for the technicians that service their regulated fire suppression systems.

[105] These may include, but are not limited to, other EPA regulations, DOT regulations, Occupational Safety and Health Administration (OSHA) regulations, codes and standards of NFPA, and other federal, state, or local fire, building, safety, and environmental codes and standards.

Response: EPA acknowledges commenters' support of the fire suppression technician training requirement and is finalizing this requirement as proposed with only a change to the compliance date to January 1, 2026, to align with other changes such as the compliance date for the use of recycled HFCs for servicing and/repair. The Agency acknowledges the request for consistent course content across the country; however, the Agency considers the affected entities able to design effective training on their own taking into consideration their needs and practices, as relevant. That said, on a voluntary basis, EPA could review and provide feedback on training programs and materials. The Agency has provided a list of the primary topics to be included in the training: 1) an explanation of the purpose of the training requirement, including the significance of minimizing releases of HFCs and ensuring fire suppression technician safety, 2) an overview of HFCs and environmental concerns with HFCs, 3) a review of relevant regulations concerning HFCs, including the requirements of the HFC emissions reduction program for fire suppression equipment, and 4) specific technical instruction relevant to avoiding unnecessary HFC emissions during the servicing, repair, disposal, or installation of fire suppression equipment at each individual facility. EPA may provide suggested resources to assist entities to develop the training as necessary.

e. Recycling of HFCs prior to disposal of fire suppression equipment containing HFCs

EPA proposed requirements related to the disposal of fire suppression equipment. The intent of these requirements is to ensure that HFCs have been recovered and recycled from the equipment prior to the final step of the disposal of the equipment so that HFCs are not released during the disposal of the equipment. EPA is requiring owners and operators of fire suppression equipment containing HFCs (including an HFC blend) dispose of this equipment by recovering the HFCs themselves or by arranging for HFC recovery by a fire suppression equipment manufacturer, distributor, or a fire suppressant recycler. EPA also is requiring that owners and operators dispose of HFCs used as a fire suppression agent by sending it for recycling to a fire suppressant recycler or a reclaimer certified under 40 CFR 82.164 or by arranging for its destruction using one of the controlled processes listed in 40 CFR 84.29. Consistent with 40 CFR part 82, subpart H, disposal of HFCs used as a fire suppression agent means the process leading to and including discarding of from HFC-containing equipment. The voluntary industry standards that apply to the uses of HFCs in fire suppression equipment, NFPA 2001 for fire suppression systems and NFPA 10 for fire extinguishers, contain no current requirement for the recovery and disposal of HFCs prior to disposal of equipment. Efforts by the industry to minimize emissions of HFCs used in the fire suppression sector have to date been on a voluntary basis. For example, the VCOP includes as part of its emission reduction strategies during storage, handling, and transfer of HFCs to recover the agents after the end of the equipment's useful life and either recycle or destroy them. These requirements will minimize emissions of HFCs through recovery of the agent prior to disposal of the equipment and ensure recycling or proper disposal of the HFC occurs broadly within this sector of use. Under the requirements, the owners and operators of this equipment (*e.g.*, specialized fire suppression systems containing HFCs that protect high value equipment, such as electronic server rooms or oil and gas production facilities) must ensure that these HFCs are recovered from the fire suppression equipment before it is sent for disposal, either by recovering the HFCs themselves before sending the equipment for disposal or by leaving the HFCs in the equipment and sending it for disposal to a facility (*e.g.*, fire suppression equipment manufacturer, a distributor, or a fire suppressant recycler) operating in accordance with industry standards, *i.e.*, NFPA 10 and NFPA 2001 standards, as applicable. The owner or operators of fire suppression equipment also must recover any HFCs as part of the disposal of such equipment be disposed of by sending it to a fire suppressant recycler operating in accordance with the relevant industry standards, which EPA understands to be the NFPA 10 and NFPA 2001 standards (depending on the type of equipment), by sending it to a reclaimer certified under 40 CFR 82.164, or by arranging for its destruction by a technology that is listed as an approved technology for destruction of the relevant regulated substance in the regulations at 40 CFR 84.29. As part of implementing subsection (h)(1) of the AIM Act, these requirements control practices, processes, or activities regarding the disposal of such fire suppression equipment by establishing certain requirements that must be met as part of the disposal process and involve a regulated substance.

Owners and operators of this fire suppression equipment who recover HFCs prior to disposal may already be aware of the importance of HFC recycling given prior communication efforts by the industry and may already take steps to ensure recovery of HFCs prior to disposal. The recycling of HFCs plays an important role in providing the fire suppression sector with continued supply of HFCs for fire suppression equipment during servicing. Industry trade organizations have encouraged owners and operators of fire suppression equipment and those disposing of HFCs to contact fire suppression equipment manufacturers, distributors, or fire suppressant recyclers to ensure that HFC is safely recovered from equipment and recycled for future use. Therefore, the requirements are likely consistent with current industry practices. Most fire suppression systems and extinguishers in use today are purchased, installed, and serviced by fire suppression equipment distributors. EPA is aware that there are established distribution channels within the commercial and industrial sectors where these specialized systems are used and that industry representatives indicate that the simplest way in their opinion to ensure proper recycling of HFCs is to encourage equipment owners return equipment containing HFCs to distributors.[106] EPA values using established industry practices where such practices exist and can be used to meet the intended goals.

Comment: One commenter expressed support for the requirements in sections 84.110(e) and 84.110(f) on the disposal of fire suppression equipment and the disposal of HFCs used in fire suppression. Another commenter also supported the proper disposal of HFC fire suppression equipment and agents.

Response: EPA acknowledges the commenters' support for the requirement to recycle of HFCs prior to disposal of fire suppression equipment containing HFCs and is finalizing as proposed requirements to recover and recycle HFCs prior to the final step of disposal of the fire suppression equipment.

f. Recordkeeping and reporting

EPA is finalizing recordkeeping and reporting requirements on the fire suppression provisions under subsection (h) for HFCs used in the installation of new equipment and servicing and/or repair of existing equipment. As part of implementing subsection (h)(1) of the AIM Act, these provisions control practices, processes, or activities regarding servicing, repair, disposal, or installation of fire suppression equipment, and involve a regulated substance. For example, the requirements control recordkeeping and reporting practices, process, or activities for servicing and repair that involves HFCs.

EPA is requiring covered entities in the fire suppression sector to provide data on HFCs to the Agency. The fire suppression industry is familiar with data collection and reporting as

[106] HARC comments, dated November 7, 2022, to Notice of Data Availability Relevant to Management of Regulated Substances Under the American Innovation and Manufacturing Act of 2020 are available in the docket (EPA-HQ-OAR-2022-0606) for this rulemaking at *https://www.regulations.gov*.

some of the entities in this industry are voluntarily reporting data to HEEP as mentioned in section IV.F.2.b of this preamble. Relevant reporting entities covered under this requirement include entities that perform first fill of equipment, service (*e.g.*, recharge) equipment and/or recycle regulated substances. Relevant entities include companies, such as equipment manufacturers, distributors, agent suppliers or installers that recycle regulated substances. Records related to the fire suppression sector must be maintained for three years. Specifically, the covered entities must submit a report electronically, in the manner specified by EPA, to the Agency annually by February 14 of each year, covering the prior year's activity from January 1 through December 31 (after publication, the first annual report must be sent to the Agency on February 14, 2027):

- The quantity of material (the combined mass of regulated substance and contaminants) by regulated substance broken out by sold, recovered, recycled, and virgin for the purpose of installation of new equipment and servicing of fire suppression equipment;
- The total mass of each regulated substance broken out by sold, recovered, recycled, and virgin; and
- The total mass of waste products sent for disposal, along with information about the disposal facility if waste is not processed by the reporting entity.

Covered entities must maintain an electronic or paper copy of the fire suppression technician training as discussed in IV.F.2.d, and EPA can request to view a copy of the training on an as needed basis. EPA is also requiring facilities to document that they have provided training to personnel. For example, local personnel records could be annotated, indicating where and when the training occurred. Alternatively, records could be centralized. Where EPA established requirements for recordkeeping, we are requiring that the records be maintained for three years in either electronic or paper format.

As discussed in section IV.F.2.e, EPA is requiring that covered entities maintain records documenting that HFCs are recovered from the fire suppression equipment before it is sent for disposal, either by recovering the HFCs themselves before sending the equipment for disposal or by leaving the HFCs in the equipment and sending it for disposal to a facility (*e.g.*, fire suppression equipment manufacturer, distributor, or a fire suppressant recycler). Such records must be maintained for three years.

The recordkeeping requirements in this action do not change any recordkeeping and reporting requirements for fire suppressant recycling per 40 CFR 84.31(j) and EPA is not reopening or revisiting those requirements through this action.

Comment: A couple commenters expressed concerns about the requirements for reporting and recordkeeping as being onerous and unnecessary. The commenters stated that the current requirements under the Allocation Program provide sufficient information for EPA to track the amount of HFCs being used and recycled for fire suppression. The commenters also claimed that the domestic movement of halons or HCFCs used for fire suppression have had no history of illegal activity, while the high GWPs of fire suppression agents make it unlikely that fire suppression equipment be used to illegally move HFCs. The commenters also claimed that existing reporting, recordkeeping, and testing requirements under 40 CFR 84.31(j) have been challenging for the industry, to a degree that companies in the sector who previously performed HFC recycling in-house no longer perform that service to avoid EPA reporting requirements. The commenters also stated that if the proposed reporting and recordkeeping requirements take effect, companies may choose to not to install or service HFC-based equipment, which they claimed would work against the stated goal of the AIM Act framework rule to stimulate HFC recycling and could lead to increased HFC emissions. Additionally, the commenters stated that the management of halons in the United States over the last several decades has demonstrated a model of collaboration between industry, government, and users, which the commenters maintained has been accomplished with the necessary reporting requirements on manufacture, import, and export. One of the commenters claimed that the degree of reporting and recordkeeping requirements in the existing requirements and the proposed action makes the regulation burdensome, while bringing no environmental benefit. The commenter claimed this burden would further disrupt the market balance currently allowing for environmentally responsible, circular economy, commercial options. The commenter stated that increasing the burden of recordkeeping and reporting beyond that which is currently proven successful, would provide no value to EPA or industry, and would add what they characterized as unnecessary complexity to an already challenging situation. The other commenter questioned why EPA needs a report of every HFC-based fire protection system or extinguisher that is sold or serviced in the United States.

Response: EPA acknowledges the time and resources that reporters dedicate to fulfilling reporting requirements. EPA considers these recordkeeping and reporting requirements to be a reasonable approach to assessing compliance with requirements under subsection (h) to help ensure the rules serve their intended purposes of minimizing releases of HFCs from fire suppression equipment. Additionally, the fire suppression industry is familiar with data collection and reporting under HEEP, which helps industry minimize emissions by setting benchmarks, among other things. HEEP supports successful implementation of the elements of the VCOP. EPA acknowledges that the fire suppression industry has been voluntarily reporting under HEEP, however because it is voluntary and managed by a third party, EPA could not reasonably assess compliance. As a result, the Agency disagrees with the commenters' assertion that recordkeeping and reporting would bring no environmental benefit. Under 40 CFR part 84, subpart A, information is collected for the purposes related to the Allocation Program and requested from fire suppression recyclers only. EPA is requesting information from covered entities under this provision to account for the management of HFCs and to minimize releases in the fire suppression sector. EPA intends to limit to the extent practicable duplicative burden between part 84 subparts A and C by using the same reporting systems. If there are any duplicative requirements, entities would only report once. As noted in section II.B. of this document, recordkeeping and reporting under the AIM Act is also supported by section 114 of the CAA, which applies to the AIM Act and rules promulgated under it as provided in subsection (k)(1)(C) of the AIM Act.

Comment: Another commenter stated that fire suppression systems can accidently be triggered to release the regulated substance (*e.g.*, electronic failure) and are not situations of intentional release or releases due to failure to maintain the system. The commenter suggested that EPA require, under 40 CFR 84.110(g), that the owner/operator maintain documentation for 3 years from the date of release of any accidental releases of a regulated substance from a fire suppression system that was not a result of failure to maintain the system. The commenter also requested EPA specify the address or location of where to send the report requested in 84.110(g).

Response: EPA acknowledges the suggestion for including the date of release of any accidental releases of a regulated substance from a fire suppression system that was not a result of failure to maintain the system. EPA understands that accidental releases in these fire suppression systems are relatively rare, and any releases are typically addressed quickly due to the nature of the specialty equipment these fire suppression systems are protecting. For these reasons, EPA is not finalizing such a requirement because the Agency does not plan to use this info at this time.

Reports requested in 84.110(g) must be submitted electronically, in the manner specified by EPA.

G. What requirements is EPA establishing for handling disposable cylinders?

1. Requirements for disposable cylinders

EPA proposed to require that disposable cylinders containing HFCs and that have been used for the servicing, repair, or installation of refrigerant-containing equipment or fire suppression equipment must be sent to an EPA-certified reclaimer or a fire suppressant recycler. EPA also proposed that these entities (*i.e.*, reclaimers and fire suppressant recyclers) must remove all HFCs, including any remaining amount after the cylinders are considered empty for servicing, repair, and installation purposes (*e.g.*, the heel), prior to discarding these cylinders. The Agency proposed a compliance date of January 1, 2025, for requiring that disposable cylinders be sent to a reclaimer or fire suppressant recycler and for the removal of HFCs from disposable cylinders. EPA also proposed that the remaining heel in containers that have been used in the servicing, repair, or installation of equipment would not be considered a virgin regulated substance. Additionally, EPA requested comment on an alternative approach that would involve requiring the final processor of a disposable cylinder to ensure that all regulated substances, including the remaining heel, have been recovered prior to final disposition of the cylinder; or a combination of the lead proposal and this alternate approach. Related to the alternative approach, EPA discussed the consideration of recordkeeping requirements that would be necessary for the alternative approach and requested comments on other relevant factors such as the level of vacuum needed to ensure proper evacuation of the heel and information on recovery machines available to perform the heel removal. EPA also requested comment broadly on the current channels by which disposable cylinders are transported to have the heels removed.

EPA is finalizing aspects of the proposal, with modifications, after consideration of the comments and information received on the proposed rule. First, EPA is requiring that disposable cylinders that contain HFCs and that have been used for the servicing, repair, or installation of refrigerant-containing equipment or fire suppression equipment must be sent to a reclaimer, fire suppressant recycler, or a final processor for recovery of the heel. EPA is also requiring that the removed heel must be sent to an EPA-certified reclaimer for further processing. In the case where disposable cylinders contain a heel of an HFC refrigerant that has flammability characteristics (*i.e.*, class 2 or class 2L), EPA is finalizing that final processors or wholesalers/distributors may remove these heels that would be considered ignitable spent refrigerant under 40 CFR part 266, subpart Q, as long as the recovered ignitable spent refrigerant is sent to an EPA-certified reclaimer meeting the RCRA alternate standards, as described in section IV.H below. The Agency is also delaying the proposed compliance date from January 1, 2025, to January 1, 2028, to allow additional time for implementation (as described in subsequent responses to comments).

Finally, the Agency is establishing an alternate approach informed by comments received on the proposed rule for appropriate levels of evacuation of the heel from disposable cylinders. As discussed in response to comments in this section, EPA received comments suggesting an evacuation level of 15 inches of mercury (in-Hg) for disposable cylinders. After consideration of the comments, EPA is establishing an alternate compliance method where a certified technician evacuates a disposable cylinder to a level of 15 in-Hg (relative to a standard atmospheric pressure of 29.9 in-Hg), certifies that they have done so, and provides a certification statement accompanying the evacuated disposable cylinder to the final processor. If these criteria are met, a certified technician may discard the cylinder to a final processor, and the cylinder would not need further processing or be sent to a reclaimer or fire suppressant recycler.[107] In establishing this alternate compliance method, the Agency does not intend for final processors to accept certification statements from a certified technician if the final processor knows or has reason to know that a certification statement contains falsified information (*e.g.,* if there are clear indications that the heels within a disposable cylinder have not been evacuated properly, such as punctures in the cylinder that would suggest improper venting of the cylinder's heel), it would be inconsistent with the intent of this provision for the final processor to accept those cylinders and the accompanying certification. The certification statement must be signed by the certified technician who removed the heel and accompany each disposable cylinder discarded in this way. If all the disposable cylinders in a shipment were evacuated by the same technician, the technician may provide a single certification that covers each of the cylinders in the shipment. The certification must include the statement and information as provided in 40 CFR 84.116(e). EPA is also finalizing that a final processor who receives a disposable cylinder being discarded in this way must maintain a record of the signed certification statement for three years.

[107] EPA clarifies that under 40 CFR 261.7(b)(2), a container that has held a hazardous waste that is a compressed gas is empty when the pressure in the container approaches atmospheric. Where a disposable cylinder that contained a refrigerant with mild flammability characteristics (*e.g.*, class 2 or 2L) is being discarded using the alternate compliance method, evacuating to a vacuum of 15-in Hg would also meet the requirements for an "empty container" under 40 CFR 261.7(b)(2), since the vacuum of 15 in-Hg would be an evacuation level beyond atmospheric pressure.

Comment: Many commenters generally supported the proposed requirements to have disposable cylinders sent to certified reclaimers or fire suppressant recyclers for removal of the remaining heel. Some commenters stated that the requirements would support the goals of subsection (h) aimed at minimizing releases and maximizing reclamation. Many other commenters opposed the proposed requirements with a few commenters requesting that EPA eliminate the requirements from the final rule altogether.

Response: EPA acknowledges the comments in support of these provisions and responds that the Agency is finalizing these requirements with additional flexibilities and a later compliance date to ensure effective and efficient implementation. EPA agrees that these requirements are important for meeting the purposes identified in subsection (h) of the AIM Act and promote increased opportunities for reclamation. As discussed in the proposed rule, heels from used disposable cylinders provide an important source of material that can bolster the amount of refrigerant that can be reclaimed. HFC releases of heels are far more likely to occur from disposable cylinders than from other types of cylinders, and those amounts of HFCs released are not available for reclamation. Comments in opposition of the requirements that were proposed are discussed in more detail in this section.

Comment: Some commenters questioned EPA's authority to require that used disposable cylinders be sent to reclaimers or fire suppressant recyclers. One commenter stated that the proposed provision was outside the scope of the authority of subsection (h). The commenter opposed EPA's interpretation of "any practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment…" to cover practices, processes, and activities that may occur before or after the servicing, repair, disposal, or installation of equipment, stating that the interpretation took a limited grant of authority in subsection (h) to an unlimited grant of authority over the entire HVACR supply chain. The commenter stated that the provisions to ship disposable cylinders containing heels is beyond the authority granted in subsection (h)(1), even it can increase refrigerant reclamation. Another commenter stated that the requirement for used disposable cylinders to only be sent to reclaimers or fire suppressant recyclers was arbitrary and capricious and not adequately justified and that EPA did not properly consider others in the supply chain that could remove the heel from disposable cylinders. Another commenter stated that the authority under subsection (h) does, in fact, allow EPA to establish this provision, as it aligns with the statutory language in subsection (h).

Response: EPA agrees with the commenter's conclusion that this provision aligns with EPA's authority under subsection (h) and disagrees with the comment asserting that EPA is interpreting an unlimited grant of authority of the HVACR supply chain under subsection (h). As described above in this notice and in the proposal, subsection (h) of the AIM Act directs EPA to promulgate regulations to control, where appropriate, any practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment that involves regulated substances, among other things, for purposes of maximizing reclaiming and minimizing the release of a regulated substance from equipment and ensuring the safety of technicians and consumers. EPA interprets this authority to include the comprehensive practice, process, or activity regarding the servicing, repair, disposal, or installation, including aspects that may occur before or after the servicing, repair, disposal, or installation of the equipment. This interpretation is supported by both the text of the provision and the statutory context in which it appears. With respect to the text, Congress authorized EPA to regulate "any practice, process, or activity *regarding* the servicing, repair, disposal, or installation of equipment" (emphasis added). The term "regarding" is broad and indicates that Congress intended for EPA's authority to encompass not only the actions or events directly involved in the servicing, repair, disposal, or installation of equipment, but also practices, processes, or activities that relate to or concern the servicing, repair, disposal, or installation of equipment. This could include practices, processes, or activities that occur before or after the servicing, repair, disposal, or installation. Similarly, by authorizing regulations to control "any practice, process, or activity," Congress conveyed EPA authority to control actions or situations that occur throughout, or at any point, during the relevant practice, process, or activity. This interpretation is also consistent with ensuring that the regulations can fully serve the purposes identified in subsection (h)(1) ("maximizing" reclamation, "minimizing" release, and "ensuring" safety), as EPA may need to regulate actions or situations that occur before or after the servicing, repair, disposal, or installation to achieve these purposes. EPA acknowledges the statutory language to promulgate regulations "as appropriate" to control such practices, processes, and activities. Based on EPA's interpretation of this provision, subsection (h)(1) authorizes the Agency to develop regulations that include provisions for the handling of HFCs in a disposable cylinder when the cylinder and a portion of the HFCs contained therein were used in the servicing, repair, disposal, or installation of equipment. The use of HFCs in these cylinders is a typical practice during servicing, repair, or installation of equipment and the associated disposal of the cylinder, and typically some HFCs remain in the cylinder after such use, unless steps have been taken to remove them from the cylinder. Accordingly, the disposition of the HFCs remaining in the cylinder are inherent to the use of HFCs in such cylinders in the servicing, repair, disposal, or installation of equipment. Thus, the Agency considers these requirements as establishing appropriate controls for a practice, process, or activity as related to the servicing, repair, or installation of equipment.

Comment: A number of commenters questioned the amount of HFC refrigerant that remain in the heel of disposable cylinders. Some commenters provided information on the amount left in the heels of disposable cylinders based on experience and data. Commenters provided various estimates, including (percentages based on a nominal 30-pound disposable cylinder): 0.1 pounds (~0.33%), 0.3 pounds (1%), 0.5 pounds (~1.67%), 1.25 pounds (~4.16%), 1.5 pounds (5%). One commenter cited various other estimates including 1.85 percent from CARB, noting this was also corroborated by Heating, Air-conditioning and Refrigeration Distributors International (HARDI), and 0.2 percent to 4.4 percent from Chemours, an HFC producer. The commenter also cited National Refrigerants, a reclaimer, stating that 90 percent of cylinders have a remaining heel of 0.5 pounds (about 2 percent by weight) or less and that 60 percent have no discernible heel, One commenter provided sample data from UL testing of an SAE J2788 AC Service Machine, noting the net remaining heel was around 50 grams (~0.1 pounds), and was typical of heels in disposable cylinders used in the MVAC industry. Another commenter stated that around two-thirds of used cylinders are completely empty. Other commenters stated that the remaining heel in disposable cylinders is minimal as contractors and technicians have a strong incentive use as much refrigerant from disposable cylinders as possible. Another commenter provided data on remaining refrigerant in small cans of automotive refrigerant per CARB's regulations, with a remaining amount of 4 percent.

One commenter stated that there were inconsistencies in the draft RIA and supporting Cylinder Analysis draft TSD.[108] Further, the commenter stated EPA did not clearly and

[108] EPA further notes that this comment stated that it was incorporating the OMB Pass-Back records in EPA-HQ-OAR-2022-0606-0028 with the stated goal of ensuring that these records will be included within the administrative record for any subsequent judicial review of this rulemaking. EPA responds that section in section 307(d)(7)(A) of the CAA is clear that the record for judicial review does not contain interagency review materials as described in CAA 307(d)(4)(B)(ii).

consistently identify heel estimates used when assessing potential benefits of the cylinder management requirements. The commenter stated that the proposed rule preamble was not clear in how the heel estimate of 1.25 pounds was concluded, while relevant analyses assumed a heel of 0.96 pounds. The commenter stated that EPA referenced personal communications for the heel estimates but did not make clear the sources of the information or provide them or supporting documentation in the docket for the rulemaking and that other relevant studies are available and could have been used to provide information on concluding an accurate heel estimate. Such studies were provided to EPA in previous comments to the Allocation Framework Rule. The commenter provided studies and relevant data that they stated could be used to estimate the heel in a disposable cylinder. The commenter also stated that EPA's assumption that 95 percent of all cylinders are vented is an extraordinary assumption, though 95 percent may be feasible if it is based on the amount of cylinders that are not returned to companies after they are sold, as there is currently no nationally applicable cylinder take-back program, and licensed professionals who use the cylinders would not be expected to return them but, rather, dispose of them properly without illegal venting, such as through recovery of heel with a vacuum pump in the field; in-house refrigerant recovery or recycling; or sending non-refillable cylinders to a reclamation facility. The commenter noted previously available information on rates of cylinder venting.

Response: EPA acknowledges these comments and understands that the estimate of a typical heel in a disposable cylinder may vary. Given the wide variety of estimates from commenters on the amount of heel in a typical disposable cylinder, EPA maintains its central estimate that a typical heel is 4 percent by weight of the cylinder. We have updated the Refrigerant Cylinders: Use, Disposal, and Distribution of Refrigerants TSD to more clearly and consistently show this assumption as well as a low and high estimate. In Appendix K of the RIA addendum, the Agency also provides a sensitivity analysis using a value of 1.2 percent, as provided by a commenter. The amount (mass) of an HFC held in a full disposable cylinder varies by HFC, and hence the amount of the heel would vary. Although typical full sizes include 30 pounds (*e.g.*, HFC-134a) and 25 pounds (*e.g.*, R-410A), to be conservative EPA used 24 pounds (*e.g.*, R-404A) as the cylinder size, thus leading to a heel of 0.96 pounds or 0.288 pounds in the sensitivity analysis. As one commenter pointed out, at proposal, EPA had estimated higher heels; this was due to the higher estimates of charge size of cylinders and has been corrected in the RIA addendum. EPA further notes that the information that it was relying on for the analyses for the proposed rule were reflected in the draft TSD and RIA addendum, which were included in the docket for this rulemaking. Thus, the relevant information that was considered in developing the proposed rule was available in the docket at the time of proposal.

In addition to the above sensitivity analysis, EPA performed analyses assuming a much higher number of disposable cylinders, assuming full recovery of a large share of such cylinders, and a combination of all three assumptions. Refer to the RIA addendum and the Economic Impact and Benefits TSD for additional details and results.

Comment: One commenter expressed concern with the Agency's draft RIA addendum and conclusions regarding sufficiency of the infrastructure necessitated by the proposed new cylinder management and tracking requirements, as well as the time and costs associated with its implementation and broad application across multiple industry sectors; requiring thousands of businesses, including many small businesses, to comply with extensive new obligations on extremely short timelines. The commenter stated that EPA must use relevant data to develop a reasonable estimate of the number of refrigerant cylinders that these thousands of newly regulated entities will be required to manage and track, stating that the assumption that "4.5 million HFC cylinders will be sold in the United States in 2025" represents a substantial underestimation that is not based on, and in fact, fails to consider, relevant and credible data in the Agency's possession, including comments on the proposed 2021 NRC Ban and confidential sales data provided to the Agency, as well as data from the United States International Trade Commission. The commenter further stated that the Agency's 4.5 million cylinder estimate only represents the number of 30-pound refrigerant cylinders used annually in the United States, and this estimate does not include 15-pound cylinders, 50-pound cylinders, or any other bulk refrigerant containers that would be subject to the proposed rule's cylinder management and tracking requirements, noting that without a reasonable estimate of the universe of refrigerant cylinders potentially impacted, EPA cannot assess small business impacts as required by the Regulatory Flexibility Act (RFA) or the cost of the proposed rule's recordkeeping and reporting requirements under the Paperwork Reduction Act (PRA). The commenter urged EPA reevaluate its conclusions in light of the data provided to the Agency throughout the course of multiple cylinder-related rulemakings and to reconsider the cylinder management. The commenter stated that proposed requirements do not appear to be based on a complete and legally sufficient analysis of the best available data, and that EPA may have overstated the environmental benefits of the proposed cylinder management.

Response: EPA acknowledges this comment and reads it as referring to the proposed requirements for container tracking as well as the requirement to remove heels from disposable cylinders. In response to the former, EPA is not finalizing cylinder tracking requirements in this rule. In response to comments on managing the removal of heels from disposable cylinders, please see the response above related to additional considerations and estimates in the RIA addendum.

EPA also responds that the requirements for removing the heels from disposable cylinders before they are discarded are being modified from the proposal, based on comments received on the proposal and further considerations. EPA is finalizing additional flexibilities, including allowing the heels of disposable cylinders to be removed at different points in the reverse supply chain (*e.g.*, by a final processor or a wholesaler/distributor). Further, EPA is delaying the compliance date for these requirements from January 1, 2025, to January 1, 2028, to allow for additional time for industry to become familiar with the regulations and secure necessary connections within the reverse supply chain. EPA is also establishing an alternative approach to allow disposable cylinders that are evacuated to a specified level of vacuum to be discarded with an accompanying certification. EPA provides additional details on these requirements in responses throughout this section. Overall, these modifications provide additional flexibilities as compared to the proposed requirements while achieving the statutory requirements of subsection (h) of the AIM Act.

With respect to the number of cylinders that the requirement to remove heels covers, EPA notes that it has used data from the commenter to perform a sensitivity analysis. See the RIA addendum and Economic Impact and Benefits TSD for additional details.

Comment: EPA received some comments related to the data collection and tracking of transporting disposable cylinders and the associate heel recovery. Some commenters were opposed and stated that the proposed tracking and data collection requirements were burdensome. Another commenter stated concerns that the effectiveness of compliance of the requirements to remove heels from disposable cylinders would be lacking absent adequate tracking provisions. Another commenter expressed support for tracking the cylinders until they reach a reclaimer or fire suppressant recycler.

Response: EPA acknowledges these comments. The Agency is not finalizing as part of this rulemaking under the AIM Act the proposed provisions for container tracking of HFCs that could be used in the servicing, repair, and/or installation of refrigerant-containing or fire suppression equipment. However, as discussed in this section the Agency is finalizing provisions to ensure that used disposable cylinders are properly handled and the removed heels are sent to reclaimers. EPA is including flexibilities, as discussed throughout this section, for the removal of the heel from used disposable cylinders. EPA understands that these flexibilities are, in some cases, consistent with current practices for the management of used disposable cylinders to remove the heel, such that entities in the reverse supply chain are capable of removing the heel and consolidating to a recovery cylinder to send to reclaimers. EPA is also requiring that heels removed from used disposable cylinders must be sent to reclaimers, where the used disposable cylinder is not already being directly sent to a reclaimer. Further, the Agency is establishing an alternate approach allowing certified technicians to certify that a disposable cylinder has been evacuated to a specified level of vacuum and the cylinder can be discarded with no further processing.].

Comment: Multiple commenters voiced concerns regarding the ability and capacity of reclaimers to process the influx of many disposable cylinders and remove heels. One commenter requested that EPA consider allowing reclaimers to use a batch method of removing the heels from disposable cylinders and report as a net amount, rather than per cylinder. A couple of commenters noted that reclaimers may not be prepared and have the capacity to handle the volume of incoming disposable cylinders and that the compliance timeline is inadequate. The commenters stated the need for additional storage space for the cylinders and potential investments in transfer, recovery, and crushing and disposal equipment. Some commenters further stated that the associated costs of these equipment may ultimately be passed down in the form of charging to accept disposable cylinders. Another commenter stated that the Agency confounded the distinct actions of removal and reclamation, and this requirement would be burdensome on reclaimers to be responsible for removal and reclaiming the material.

One commenter further expressed uncertainty on whether EPA-certified refrigerant reclaimers have adequate capacity to manage the volume of HFCs that would be required to be reclaimed or whether that capacity can sufficiently increase within the proposed compliance deadline. The commenter cited that the Agency's solicitation of comments on whether to allow recovery by parties other than certified reclaimers suggests its concern that the current 63 EPA-certified refrigerant reclaimers may not be able to timely manage HFC recovery from 4.5 million estimated cylinders. The commenter further stated that the actual domestic refrigerant cylinder market of nearly twice this size will surely create a massive refrigerant recovery bottleneck that will cascade throughout the refrigeration and HVACR supply chain and could undermine the purpose and intent of the proposed rule.

Response: EPA acknowledges the comments related to logistical concerns with handling the influx of disposable cylinders with the proposed requirements. In response to comments stating concerns for reclaimers to have capacity, storage space, and other resources to process the influx of disposable cylinders, the Agency notes we are finalizing modifications to the provisions for handling of used disposable cylinders. As explained in this section, EPA is finalizing flexibilities to these requirements that would achieve the goals of subsection (h) of the AIM Act. These flexibilities would also help alleviate the number of disposable cylinders that would be sent directly to a reclaimer to have the heel removed and processed. Among these provisions, EPA is finalizing that used disposable cylinders can be sent to a final processor or back through the reverse supply chain to have the heels removed and consolidated. EPA recognizes these current channels in the reverse supply chain or the waste distribution chain that make for effective processing of used disposable cylinders and removal of heels for ultimate reclamation or, for fire suppressants, recycling. EPA anticipates that this would reduce the number of individual used disposable cylinders that a reclaimer receives for heel removal and processing. Further, the Agency is establishing a compliance date of January 1, 2028, as compared to January 1, 2025, in the proposed rule to allow industry to prepare effectively.

EPA acknowledges there is a value in disposable cylinders and estimates those benefits in the RIA addendum and the Economic Impact and Benefits TSD. That analysis includes estimated costs for the transportation, assumed by truck, required as compared to business-as-usual practices. Whether a wholesaler chooses to inventory disposable cylinders that are returned, remove the heels and consolidate them, or expeditiously send them to locations allowed under the final rule, is a business decision; therefore, any value lost due to occupying inventory space is not assessed as doing so is not a requirement in this final rule and EPA does not have information on how to place a value or cost estimate on such inventory space.

In response to the comment about processing removed heels in a batch method as compared to at the individual cylinder level, EPA views this comment as related to the proposed container tracking requirements. As explained in section I.B, the Agency, at this time, is not taking final action on container tracking requirements, and this rulemaking does not establish reporting requirements for the amounts of heels removed by reclaimers at the individual cylinder level. Additionally, reclaimers who receive disposable cylinders and remove the heels are not required to record data for each individual cylinder received. Reclaimers will continue to report in their totals of refrigerant received or reclaimed when reporting under the CAA 608 programs (40 CFR part 82, subpart F) and the HFC Allocation Program (40 CFR part 84, subpart A).

EPA acknowledges comments related to current reclaimer capacity and meeting supply of reclaimed refrigerants as required to support provisions in this rulemaking. EPA addresses comments related to reclaimed refrigerant supply in section IV.E.2 of this rulemaking. Regarding comments related to the uncertainty of reclaimers to process the influx of a volume of HFCs being sourced from heels of disposable cylinders, EPA responds that comments to the proposed rule describe that reclaimers have the capacity to process the volume of HFCs. EPA is aware of reclaimers expanding capacity volume-wise and increasing capacity of advanced separation technologies to effectively process additional material. EPA notes that comments related to uncertainty of reclaimers' capacity received in this rulemaking were related to processing of the influx of disposable cylinders and removing heels. The additional flexibilities being finalized related to the handling of used disposable cylinders help to address these concerns (as addressed in responses in this section).

Comment: EPA received multiple comments related to the distribution chains that would support the movement of disposable cylinders to reclaimers. Some commenters stated that the distribution chains for returning recovered materials, as EPA alluded to in the proposed rule, may have difficulty accommodating the increase in magnitude of disposable cylinders per the proposed requirements, since these distribution chains are typically more used for return of recovery cylinders. Other commenters noted that the existing distribution chains could be used to support the movement of the disposable cylinders per the proposed requirements. One commenter stated that in current practices, contractors may already be consolidating recovered material into a recovery cylinder (including heels) before taking them to a distributor. Another commenter stated that there are multiple avenues for refrigerant recovery from cylinders, such as current practices to send disposable cylinders to reclaimers, wholesale distribution-operated cylinder recycling programs, and allowing contractors to recover the remaining refrigerant and be compensated for sending the recovered refrigerant to a certified reclaimer. The commenter noted that while programs for returning disposable cylinders to reclaimers exist, this method for recovery of the heel may be inefficient and rely on proximity to a reclaimer.

EPA received many comments on alternate approaches that shared features with the alternate approaches described in the proposed rule, one of which would allow final processors (*e.g.*, landfill operators, scrap metal recyclers) to be the entity to recover heels from disposable cylinders prior to discarding, and another of which would have allowed more than just reclaimers to recover the heel, while still requiring that all the removed material be sent to reclaimers for further processing. Many commenters were supportive of aspects of the alternate approach in combination with the proposed requirements. One commenter stated that EPA should consider alternatives to send near empty disposable cylinders to a local appliance disposal outlet in addition to sending directly to a reclaimer. Another commenter supported the implementation of similar regulations to those for small appliance disposal under CAA section 608, such that a final processor is responsible for ensuring the remaining refrigerant is removed from a cylinder either by them or prior to them receiving the cylinder. Another commenter stated they supported alternative approaches to allowing others in the supply chain to remove heels from disposable cylinders provided the entities have associated reporting requirements for total amounts recovered annually. The commenter further noted the benefits of the alternate approach could help address any increase in transportation emissions or costs related to shipping disposable cylinders. One commenter stated that the alternate approach matches practices that are already occurring effectively where disposable cylinders are collected by recycling companies, distributors, and appliance recyclers. The commenter further stated that there may be cases where disposable cylinders that contained a unique refrigerant are sent to reclaimers as is rather than recovering and mixing refrigerants in a common recovery cylinder. Another commenter stated that another consideration could be for the cylinders to be sent back to the refrigerant company for proper disposal or recycling.

One commenter stated that the alternate approach may also provide benefits for supermarkets who may not have direct relationships with reclaimers, but rather rely on third-party service providers. The commenter noted the importance of using the existing channels to send disposable cylinders to distributers or suppliers to then be sent to a final processor or reclaimer.

Some commenters discussed other approaches to be considered for the recovery of heels from disposable cylinders. One commenter supported provisions to recover heels from disposable cylinders in general, but stated that certified technicians should be trained and able to recover heels from disposable cylinders before disposal of the cylinders. The commenter noted the efficiency and reduced transportation burden associated with allowing certified technicians or others (*e.g.*, distributors) to remove and aggregate heels to a recovery cylinder for shipping, rather than shipping many individual disposable cylinders. The commenter argued that EPA should at least conduct a lifecycle analysis of net GHG emissions in various scenarios to understand their environmental impacts. Other commenters stated that EPA could allow any certified technician to recover heels prior to disposal of the cylinder. One commenter also suggested to consider associated recordkeeping that could be subject to auditing. The commenter described an approach that would involve contractors and technicians recovering the heels from disposable cylinders prior to disposal and includes suggestions for establishing programs for cylinder returns to wholesalers or distributers. The commenter stated that the approach described could be less burdensome by extending the program to contractors and disposable cylinder users, in addition to certified technicians, and coordinating with wholesalers, reclaimers, and/or refrigerants suppliers.

One commenter was opposed to the approach to allow a final processor to recover the heel from disposable cylinders, noting this practice could lead to venting remaining heels by metal recyclers or waste disposal facilities. Another commenter, while not opposing the alternate approach, stated it is advantageous to have the disposable cylinders sent to reclaimers, enabling them to promptly reclaim and allowing EPA to gauge success through required reporting.

One commenter stated that establishing collection points, especially in areas with few EPA-certified reclaimers, could help mitigate concerns with costs and logistics, though there may still be some associated costs. Another commenter stated that requiring disposable cylinders to be sent to EPA-certified reclaimers or fire suppressant recyclers would compete for truck space with shipping recovery cylinders that are full of recovered material. Another commenter stated that the logistics and costs of being able to first aggregate heels from disposable cylinders into a larger recovery cylinder would be more efficient, and transporting one larger recovery cylinder would greatly reduce transport of many disposable cylinders.

Response: EPA acknowledges that the current reverse supply chain and waste distribution channels are varied. Many distribution channels for reclaimers are generally more limited to the processing of recovery cylinders to reclaimers, though not exclusively. EPA is also aware that many of these same channels are also currently being used for the transport of disposable cylinders with a remaining heel. As commenters noted, the current channels are effective, as many contractors or technicians may rely on sending used disposable cylinders to a wholesaler or distributer who consolidate and then send for further processing to a reclaimer. EPA is finalizing that disposable cylinders with a heel may continue to be sent through these channels with their intermediate steps to ultimately reach a reclaimer, such as through distributors or wholesalers. EPA recognizes that these current practices can be effective and allowing their continued use for processing of used disposable cylinders provides flexibilities to manage the volume of disposable cylinders being transported for recovery of the heel. The Agency notes that it may be appropriate for the distributor or wholesaler to be the entity that recovers and consolidates the heels from disposable cylinders, recognizing the improved logistics of consolidating heels to a single recovery cylinder. Where this practice may be occurring, EPA anticipates that the distributor or wholesaler has demonstrated the capability to remove all of the heel from the disposable cylinder prior to discarding. EPA expects this is reasonable as commenters have stated this is a common practice that is currently occurring for the processing of a used disposable cylinder. Further, EPA anticipates that distributors or wholesalers that are performing this practice recognize the value in the removed heel that can be sent to reclaimer.

In this action, EPA is adopting portions of the alternative approach; specifically, EPA is finalizing an option for used disposable cylinders to be sent to final processors (*e.g.*, landfill operators, scrap metal recyclers, etc.) for removal of the heel. As noted earlier in this response, EPA is also finalizing that the reverse supply chain may be utilized for the transport of used disposable cylinders to have the heel removed (*e.g.*, sent to a distributor or wholesaler capable of removing the heel). EPA is establishing requirements that heels removed by final processors or distributors/wholesalers must be sent to a reclaimer or fire suppressant recycler. The added flexibilities should allow those with used disposable cylinders to have additional options for the proper handling of such cylinders. In general, the Agency anticipates that the added flexibility will provide access to discard used disposable cylinders at locations in closer proximity to contractors and technicians, reducing transportation[109] costs and emissions associated with disposing the used cylinders. Final processors may already be receiving small appliances (*e.g.*, less than 5 pounds of refrigerant) and consistent with the regulations promulgated under CAA section 608, may already be recovering these refrigerants per those requirements and sending them for reclamation per those requirements. Further, where used disposable cylinders have been sent for processing by a final processor or a distributor or wholesaler, the removed heels would be consolidated into a common recovery cylinder. As commenters stated, this practice could help to improve logistics related to truck space for shipping materials to a reclaimer or fire suppressant recycler for further processing. Therefore, EPA is finalizing these flexibilities for sending the disposable cylinders to the reclaimers that is intended to result in the proper removal of the heel and to ensure that the HFCs from removed heels are sent to reclaimers or fire suppressant recyclers for further processing and reuse.

EPA acknowledges other comments that suggest that a certified technician be allowed to remove the heel from disposable cylinders. As described more fully in a response later in this section, EPA is finalizing an alternate approach where certified technician may certify that a heel has been removed from a disposable cylinder to a vacuum level of 15 in-Hg, relative to standard atmospheric pressure of 29.9 in-Hg. In this case, a used disposable cylinder certified to have been evacuated to a vacuum of 15 in-Hg may be discarded to a final processor without further

[109] EPA addressed transportation related costs in the draft RIA addendum and further addresses such costs in the RIA addendum accompanying this final rule.

processing. This alternate approach being finalized by the Agency helps to ensure the contents of disposable cylinders are effectively used and the remaining heel is negligible before the cylinder is discarded.]

EPA acknowledges the comments suggesting establishments of collection points for used disposable cylinders to promote further organization for the recovery of heels. The Agency agrees that collection points could be an effective avenue for facilitating the return of disposable cylinders to entities capable of properly removing the heel and disposing them. EPA is aware of reclaimers that offer services such as collection sites for returning recovered refrigerant, which may include returning used disposable cylinders. The Agency sees these collection facilities and practices as appropriate avenues for discarding cylinders and proper heel removal, so long as they are in compliance with all regulatory requirements, including those being established in this rulemaking.

Finally, EPA is establishing a compliance date of January 1, 2028, which is three years later than that proposed compliance date. The later compliance date will allow additional time for the distribution networks to be established and allow industry to set up necessary contracts and logistics for the transport of used disposable cylinders and the recovery of the remaining heels.

Comment: Many commenters expressed concerns regarding the logistics related to the proposed requirements and consideration of the net benefits (costs and GHGs emissions avoided) when comparing the potential costs and emissions related to transporting the disposable cylinders to reclaimers or fire suppressant recyclers. Some commenters stated that the transportation of the disposable cylinders would incur costs and require complex logistics. The commenters stated that the contractors or technicians using the disposable cylinders may not be located near an

EPA-certified reclaimer or a fire suppressant recycler and would be required to travel further than they normally do to dispose of a used cylinder. Further, the commenters stated that the logistics of transporting and handling the used disposable cylinders would require additional labor and coordinating with reclaimers or fire suppressant recyclers within their operating hours. One commenter noted that labor shortages are present in the industry and there may be a challenge in these requirements competing with other revenue-generating activities. Another commenter stated that shipping disposable cylinders to reclaimers is inefficient and noted that others in the supply chain are also capable of removing the heel properly per AHRI Guideline Q. Other commenters stated that the emissions associated with transporting disposable cylinders for heel recovery may exceed those avoided by recovering the heel, and the associated costs may outweigh the value of the recovered refrigerant. Further, other commenters stated that associated costs for collecting disposable cylinders could end up getting passed on to contractors or technicians and then further passed on to customers. Additional commenters expressed concerns about wholesalers' storage space for used disposable cylinders that would be accepted to then be sent to a reclaimer.

Response: EPA acknowledges these comments on the logistics of this provision and responds that the Agency is finalizing modifications that would allow for additional flexibilities for proper handling of used disposable cylinders. The final rule allows for additional avenues for the transport of used disposable cylinders and the removal of the heel; for example, as described in this section, sending used disposable cylinders to final processor or through the reverse supply chain (*e.g.*, distributors or wholesalers) for the removal of the heel to be sent to a reclaimer or fire suppressant recycler. EPA acknowledges the importance of the reverse supply chain and waste distribution chains and the capability of distributors and wholesaler to remove heels or otherwise facilitate the transport of the disposable cylinders to a reclaimer, fire suppressant recycler, or final processor for proper heel recovery and cylinder disposal. These additional avenues provide flexibility and improved logistics to returning disposable cylinders. The RIA addendum accompanying this rulemaking provides additional detail on costs and considerations of logistics described in these comments. While comments noted that a person may have limited access to returning a disposable cylinder to a reclaimer or fire suppressant recycler as proposed, it is likely that person would have access to a distributor, wholesaler, or final processor where they can transport the disposable cylinder. Further, this additional accessibility includes the consideration of proximity and other logistics, such as cutting down on the overall number of disposable cylinders that would be in transit. These considerations would reduce the overall transportation distance needed to bring these disposable cylinders to proper disposal and the number of trips, by allowing the consolidation of heels by other entities in the distribution chain. Thus, overall emissions associated with transportation of the disposable cylinders would be reduced. Further, EPA is aware that some reclaimers operator collection sites or offer services to pick up recovered refrigerant, which could be an additional avenue that provides a closer cylinder return option for returning disposable cylinders to reclaimers.

Allowing the use of the typical avenues for processing disposable cylinders (*e.g.*, through distributors or wholesalers) and the inclusion of the alternate approach to allow final processors to recover heels and dispose cylinders also would alleviate concerns related to labor and coordination with reclaimers to accept cylinders. These flexibilities would make use of existing avenues to transport and process the disposable cylinders and remove heels as they are sent along to reclaimers or fire suppressant recyclers for further reprocessing. EPA recognizes that factors such as available labor will be a consideration for covered entities as they decide amongst the expanded available compliance options on removal of heels and proper discarding of disposable cylinders. EPA is aware that reclaimers often buy back recovered refrigerant and the Agency expects that this practice would also be relevant to returned disposable cylinders with remaining heels or heels that have been recovered and consolidated from disposable cylinders. Others may choose to send cylinders to final disposal entities. Reclaimers may choose to expand the use of collection points or work with distributors. The final rule provides additional flexibility while still increasing the removal of heels from disposable cylinders for further reclamation.

Related to storage of flammable refrigerants at wholesaler facilities, as discussed in section IV.H, EPA is finalizing requirements that allow final processors or those in the reverse supply chain (*e.g.*, distributors or wholesalers) to manage ignitable spent refrigerant removed from disposable cylinders under the finalized RCRA alternative standards, which include emergency preparedness and response requirement to address the risk of fire from the storage of flammable refrigerants. As part of compliance with the RCRA alternative standards, final processors or those in the reverse supply chain (*e.g.*, distributors or wholesalers) that remove heels of ignitable spent refrigerants are required to send the materials to an EPA-certified reclaimer that is in compliance with the RCRA alternative standards. The criteria of the alternate standards are such that handling of these used cylinders is done so properly and safely.

Comment: One commenter recommended the Agency withdraw the proposed requirements for disposable cylinders and consider re-proposing in a separate action.

Response: EPA responds that the Agency is finalizing these requirements with a later compliance date and increased flexibility for achieving the outcome. The Agency notes the importance of recovering the heels from disposable cylinders as an important opportunity to help achieve the guiding goals of subsection (h) to minimize releases and maximize reclaim. The heels in disposable cylinders provide an important source of recovered refrigerant that will be necessary to help support the supply of reclaimed HFCs as the phasedown progresses and the required uses of reclaimed HFCs per this rulemaking become effective.

Comment: EPA received multiple comments about the proposed compliance dates for these requirements. Some commenters stated that the proposed compliance date of January 1, 2025, would be difficult to meet. One commenter stated that the compliance date should be no earlier than January 1, 2028, due to supply chain constraints and new processes and equipment needed in the supply chain. Another commenter stated that contracts that are in place already would need to be revised or established per this provision, but could not be done so until the regulation is final. Setting up these contracts would take longer than the anticipated time between the regulation being finalized and the proposed compliance date of January 1, 2025. The commenter suggested that the compliance date be 18 months from the final regulation being published in the FR. Another commenter stated that these provisions should not be in effect until reclaimers are able to sufficiently secure the resources (*e.g.*, recovery equipment, storage/warehouse space) and logistics (*e.g.*, agreements with scrap metal recyclers to accept the empty disposable cylinders) needed for implementation. The commenter stated that this is not practical in terms of the proposed compliance date.

Response: EPA acknowledges these comments and considerations. Consistent with commenters' suggestions, the Agency is finalizing a later compliance date. The Agency is establishing a compliance date of January 1, 2028, with these logistical and implementation challenges in mind. The delayed compliance date should allow those affected in the movement of the disposable cylinders and the reclaimers and fire suppressant recyclers who receive the cylinders to develop the infrastructure and business relationships needed to comply with the more flexible approach in the final rule.

Comment: One commenter expressed support for the Agency's proposal that the remaining heel in disposable cylinders are not treated as virgin material, noting that residual material may deviate from specifications and that recovered residual material should not be exempt from any current reclaimer reporting requirements. Another commenter stated that the remaining heel seems as though it would still be virgin refrigerant. The commenter stated that reclaimer could recover and verify the condition of the refrigerant. Further, the commenter stated that the recovered heels could be an additional stock of virgin material available to the market.

Response: EPA acknowledges these comments and, as explained in section IV.A.2, is revising the definition of "virgin regulated substance". EPA is not including an exclusion to the definition for recovered heels from containers. The Agency is, however, finalizing to not consider recovered heels towards the total virgin percentage in reclaimed HFCs, as described in section IV.E.2. As EPA understands, the removed heels from disposable cylinders may be recovered into recovery cylinders for consolidation. While best practices would dictate that the one type of HFC or HFC blend is recovered into a recovery cylinder, this may not always be the case. Removed heels may be end up in a recovery cylinder containing one or more other substances. In the case reclaimers are the ones to remove the heels from used disposable cylinders, they will typically reprocess the recovered heels to ensure the recovered materials are brought to the required purity specifications for reclaimed refrigerants.

Further, the Agency notes that material recovered and reclaimed from disposable cylinders must be reported under current reclaimer reporting requirements (*i.e.*, reporting per 40 CFR part 82, subpart F and 40 CFR part 84, subpart A). Heels directly removed by reclaimers, but not yet reclaimed, are considered as material received and should be reported as such under current reporting for material received by reclaimers. Likewise, for fire suppressant recyclers, any heels directly recovered, but not yet recycled, should be reported as recovered material per the reporting requirements established in this rulemaking (see section IV.F.2.f).

Comment: One commenter stated that a ban on disposable cylinders would have been more effective to reducing releases and maximizing the reclaim of regulated substances. Another commenter stated that EPA improperly alluded to having the statutory authority to reinstate a ban on non-refillable cylinders by stating in the proposed rule that the Agency is “not at this time proposing” to ban non-refillable cylinders.

Response: EPA acknowledges these comments. The Agency did not propose to ban the use of disposable cylinders in this rulemaking and reiterates that it is not establishing such a ban in this final rule. The statement in the proposed rule that EPA was “not at this time proposing” to establish a prohibition like the one at issue in *HARDI v. EPA,* 71 F.4th 59, 68 (D.C. Cir. 2023), was intended to describe the Agency action under consideration and how it differed from the prohibition in the Allocation Framework Rule. In the proposal, the Agency acknowledged that the prohibition had been vacated in the *HARDI* decision, as the court found that EPA had not cited adequate authority to support it. Further, as noted in response to a comment below, the Agency is acting consistent with the *HARDI* decision. Because the Agency did not propose and is not finalizing such a ban as part of this action, it need not address whether it would have authority to do so here. EPA notes that the provisions to require removal and reclaim of heels from disposable cylinders are effective to help mitigate the release of the remaining heel to the atmosphere while providing a source of recovered refrigerant to be available for reclamation.

Comment: One commenter suggested that the requirements for disposable cylinders be expanded to refillable cylinders as well. The commenter noted potential issues of not requiring that refillable cylinders be handled by reclaimers or have required heel recovery, included potential venting or discarding the refillable cylinder improperly.

Response: EPA acknowledges this comment and understands the value of ensuring removal of the refrigerant left in heels of refillable cylinders. EPA notes that the risk of venting heels and improper management after use is more common to disposable cylinders, given they are discarded and not reused. Refillable cylinders are refilled and reused so a requirement to removed refrigerant heels is unnecessary when the same refrigerant is being filled into the cylinder. In cases where the refillable cylinder would be filled with a different refrigerant, the remaining refrigerant would need to be properly removed to ensure the cylinder was completely emptied before refilling with a different refrigerant, which EPA understands is a standard practice to avoid mixing refrigerants in a refillable cylinder. Thus, EPA notes these requirements are more appropriate for disposable cylinders.

Comment: One commenter mentioned that the proposal was unclear about who is responsible for sending the disposable cylinder to a reclaimer and asked if it was the equipment owner/operator or a contractor.

Response: EPA is establishing requirements based on the cylinders that have been used in the servicing, repair, or installation of refrigerant-containing equipment or fire suppression equipment. Ultimately, the responsibility would likely fall on the person using or managing the disposable cylinder of refrigerant/fire suppressant. In most cases, the technician or contractor performing the process, practice, or activity related to servicing, repair, or installation is the user of the disposable cylinder. In other cases, the contractor or technician may report to the location (*e.g.*, a supermarket) that manages its own supply of refrigerant in disposable cylinders. In this case, the responsibility of sending the disposable cylinder may fall on the equipment owner/operator; however, they may arrange agreements with the contractor or technician to be the person sending the disposable cylinder. The logistics of sending the disposable cylinder may depend on the different practices that are used. In the case one of these entities has a working business relationship with a reclaimer, it would be feasible for that entity to manage sending the disposable cylinders to a reclaimer. In other cases, it may be more logistical to have the person who purchases the refrigerant be responsible for the return of the disposable cylinder if they typically are already returning disposable cylinders to their wholesaler or distributor, who would then be responsible for returning the removed heels or disposable cylinders to a reclaimer. Finally, as described above, EPA is finalizing, in conjunction, aspects of the alternate approach to allow disposable cylinders to be sent to final processors for the heel removal and EPA is also finalizing that used disposable cylinders may be transported through the reverse supply chain (*e.g.*, a distributor or a wholesaler) for the removal of the heel. A contractor or technician or an equipment owner/operator may wish to establish agreements with a final processor or utilize any existing business relationships they have with distributors or wholesalers to manage the disposable cylinders for heel removal and ultimately sending the removed heels to reclaimers or fire suppressant recyclers.

Comment: One commenter stated that when recovery machines are used for refrigerants, the refrigerant lubricates the machines; however, a machine strictly doing heel removal will not have this occur and will have a shorter lifespan.

Response: EPA is aware that recovery machines are used in practice to remove refrigerant from equipment and can be used to remove heels from disposable cylinders. EPA assumes that a recovery machine would be used for each of these practices, and not strictly one or the other. Further, the Agency anticipates that recovery machines would have proper maintenance to ensure that they are running efficiently and to proper operation to use the machines through their useful lifetime.

Comment: One commenter stated that the proposed regulatory text contained conflicting language about the ownership of recovered refrigerant, surplus refrigerant, and disposable containers with heels. The commenter states that the language should be clarified to not exclude companies important to the supply chain that purchase or accept recovered gas or salvage and recycling companies.

Response: EPA acknowledges this comment. The Agency did not intend to propose to limit that only one avenue (*i.e.*, sending used disposable cylinders to reclaimers or fire suppressant recyclers) would be available to send disposable cylinders to reclaimers or fire suppressant recyclers. EPA is aware and has reviewed comments on the significance of other components of the reverse supply chain (*e.g.*, distributors or wholesalers) to the transport of disposable cylinders to reclaimers and fire suppressant recyclers. The Agency also notes that we are finalizing provisions to allow the used disposable cylinders to be sent to a final processor or through the reverse supply chain for removal of the heel and ultimately sending the recovered material to a reclaimer.

Comment: Two commenters stated that the Agency define when a cylinder is considered empty and is considered to no longer contain a regulated substance, which could reduce the need to send all disposable cylinders for heel removal. One such commenter suggested that a disposable cylinder could be considered empty when the cylinder approached atmospheric pressure, as consistent with RCRA regulations; and that the pressure of the cylinder would be documented. Further, the commenter stated that EPA should state in the regulation how a reclaimer would determine that all remaining contents of a disposable cylinder have been removed, and if there is a specified pressure level that should be met. The other commenter stated that EPA must be clear by what is meant to remove all substances from a cylinder, noting current requirements for removing refrigerants from equipment to acceptable levels.

Other commenters suggested to require that heels from disposable cylinders be evacuated to a level of a minimum 15 inches of mercury (in-Hg). One commenter stated that EPA could require records be kept for anyone evacuating a cylinder, including quantity of cylinders evacuated and disposed of by refrigerant type.

Response: EPA acknowledges this comment and understands the industry seeking clarity on a finite specification of the required level of heel removal from a disposable cylinder. EPA notes that there are longstanding requirements under 40 CFR part 82, subpart F for evacuation levels of refrigerants from appliances using certified recovery machines. These requirements include evacuating to various levels of vacuum on appliances depending on the types of appliances and range from 0 to 15 in-Hg. EPA is also aware of AHRI Guideline Q on recovery and proper recycling of refrigerant cylinders.[110] AHRI Guideline Q defines an empty state for disposable cylinders as being evacuated to a vacuum of 15 in-Hg (relative to a standard atmospheric pressure of 29.9 in-Hg). EPA is not establishing a specified level of evacuation for disposable cylinders in this rulemaking. However, EPA is establishing an alternate compliance option that makes use of the evacuation level described in AHRI Guideline Q. Where a used

[110] Air-Conditioning, Heating, and Refrigeration Institute, Guideline Q: Content Recovery & Proper Recycling of Refrigerant Cylinders, 2016. Available at: *https://www.ahrinet.org/system/files/2023-06/AHRI_Guideline_Q_2016_0.pdf*.

disposable cylinder is evacuated to a level of 15 in-Hg (relative to a standard atmospheric pressure of 29.9 in-Hg), a person may discard of the cylinder and the cylinder does not require further processing or need to be sent to a reclaimer or fire suppressant recycler, if they provide a certification statement during transport to a final processor. EPA is aware that the certified recovery machines are capable of achieving the level of vacuum of 15 in-Hg to remove the heels from disposable cylinders. Where a cylinder is not evacuated to 15 in-Hg or a certification is not provided, the requirements for sending a disposable cylinder for heel removal to a reclaimer, fire suppressant recycler, final processor, or through the reverse supply chain apply. In addition, in the case of disposable cylinders containing ignitable refrigerant, such cylinders must meet the RCRA definition of empty container[111] in 40 CFR 261.7 or be managed under the applicable RCRA standards. EPA is assessing these comments and considering for a separate rulemaking as related to comments requested in the ANPRM for considerations for technicians.

Comment: While emphasizing *HARDI v. EPA*, one commenter expressed concern that EPA has yet to amend the CFR in accordance with the D.C. Circuit's binding vacatur, and indicated the absence of any conforming revisions to the CFR creates significant uncertainty throughout the industry.

Response: EPA responds that any action in response to *HARDI v. EPA* is outside the scope of this rulemaking and thus comments related to such action require no response. For purposes of public awareness, the Agency notes that it is acting consistent with the *HARDI*

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[111] EPA clarifies that under 40 CFR 261.7(b)(2), a container that has held a hazardous waste that is a compressed gas is empty when the pressure in the container approaches atmospheric. Where a disposable cylinder that contained a refrigerant with mild flammability characteristics (*e.g*., class 2 or 2L) is being discarded using the alternate compliance method, evacuating to a vacuum of 15-in Hg would also meet the requirements for an "empty container" under 40 CFR 261.7(b)(2), since the vacuum of 15 in-Hg would be an evacuation level beyond atmospheric pressure.

decision and is not implementing or enforcing the QR code and tracking requirements for all cylinders containing HFCs found at 40 CFR 84.23. EPA intends to undertake a rulemaking to formally remove this requirement from the CFR.

Comment: One commenter provided alternate considerations to address concerns of heel emissions from disposable cylinders. The commenter described their experience in cylinder design and adaptation for class A2L refrigerants, noting a resealable pressure relief valve and left-handed threads to avoid inadvertent connection to a refrigerant with flammability characteristics. Further, the commenter proposed equipping disposable cylinders with a resealable pressure relief valve to prevent fugitive emissions. The commenter also stated that disposable cylinders could be redesigned with a redundant pressure-tight seal to prevent venting by using a self-sealing valve that controls gas flow and could prevent venting. The self-sealing valve would be similar to that for small cans of automotive refrigerant. The commenter also suggested developing and deploying equipment for heel recovery and preparation of disposable cylinders for disposal. The commenter states that it may be possible to reduce venting of heels by making heel recovery and cylinder recovery easier and less time consuming. Beyond the cylinders, the commenter suggested other means of addressing venting heels, including the development of a disposable cylinder buyback program, which the commenter states could be more effective than the proposed requirements if left to be led by industry. The commenter also stated options such as heel recovery and recycling programs internal to companies, contractor-led programs where cylinders are evacuated to 15 in-Hg prior to disposal, or programs where refrigerant producers and packagers establish a seller take-back administered at local levels by wholesale customers. Finally, the commenter recommended that EPA could consider a labeling for disposable cylinders that includes a warning and disposal instructions.

Other commenters suggested that the disposable cylinders could be made of recyclable materials.

Response: The Agency appreciates the commenter's suggestions on considerations for alternative cylinder designs to minimize emissions. EPA intends to evaluate the information provided for any potential future rulemakings. While materials for the disposable cylinders are outside of the scope of this rulemaking, EPA notes that the cylinders are made of steel, which can be recycled.

Regarding alternate considerations beyond cylinder design, EPA appreciates these comments and suggestions. The Agency provided responses to similar suggestions in comment responses in this section. For example, EPA is addressing flexibilities of transporting used disposable cylinders to reclaimers and fire suppressant recyclers by including the alternate approach to allow final processor to accept disposable cylinder and recover the heel and establishing that the recovery of the heel may occur at other points in the reverse supply chain (*e.g.*, wholesalers and distributors). These entities are those that are capable of removing the heel from disposable cylinders and thus have access to the proper recovery machines. EPA also notes that while establishing collection sites may improve logistics of returning disposable cylinders for recovery of the heel, the Agency is not the appropriate entity to establish such sites under a regulatory action. Further, EPA is establishing an alternate approach considering an evacuation level of 15 in-Hg, as described earlier in this section. The Agency appreciates the suggestion to establish a labeling requirement for disposable cylinders that would describe safe and proper disposal of the cylinder. EPA is not at this time establishing such labeling requirements, but may consider such a requirement in a future rulemaking. The Agency also notes that the manufacturers of these cylinders could provide additional information on their labels if they choose to do so, as long as that information is not counter to the requirements established by this final rule.

2. Small cans of refrigerant

EPA did not propose that small cans[112] of refrigerant with self-sealing valves (*i.e.*, those that qualify for exemption from the sales restriction under 40 CFR 82.154(c)(ix)) must be sent to a reclaimer for disposal after use. EPA did not receive adverse comments on this proposed approach and is finalizing as proposed.

H. How is EPA establishing RCRA refrigerant recycling alternative standards?

EPA is finalizing standards under 40 CFR part 266, subpart Q applicable to certain ignitable spent refrigerants that are recycled for reuse that apply instead of the full RCRA Subtitle C hazardous waste requirements. The purpose of these standards is to help reduce emissions of ignitable spent refrigerants to the lowest achievable level by maximizing the recovery and safe recycling of such refrigerants during the service, repair, and disposal of appliances.

1. Nomenclature used in this section

This section uses the term "ignitable spent refrigerant" to describe the refrigerants that are potentially subject to RCRA hazardous waste regulation under the current rules, and that will now be subject to the applicable RCRA alternative standards for refrigerants when recycled for reuse under the final rule. "Ignitability" is one of the RCRA hazardous waste characteristics and is used to identify waste that may pose a risk to human health and the environment due to their

[112] Small cans of refrigerant, that typically contain two pounds or less of regulated substances, are commonly used by individuals to service their own MVACs. This do-it-yourself (DIY) servicing practice is unique to the MVAC subsector within the RACHP sector.

potential to cause fires if improperly managed.[113] The characteristic of ignitability is defined in 40 CFR 261.21. As discussed in more detail below in this section, "ignitable" is similar, but not identical, to the term "flammable" as used in ASHRAE Standard 34–2022. "Spent" is used in the same context as "spent material," which is defined in 40 CFR 261.1(c)(1) as "any material that has been used and as a result of contamination can no longer serve the purpose for which it was produced without processing." Thus, an "ignitable spent refrigerant" is a used refrigerant that cannot be reused without first being cleaned, and that exhibits the hazardous characteristic of ignitability per 40 CFR 261.21.

In addition, the terms "reclaim" and "recycle" have different regulatory purposes and definitions under RCRA than under the CAA and the AIM Act. Under RCRA, a material is "reclaimed" if it is processed to recover a usable product, or if it is regenerated. Examples are recovery of lead values from spent batteries and regeneration of spent solvents (See 40 CFR 261.1(c)(4)). Reclamation is one of the four types of "recycling" identified in 40 CFR 261.2(c) that can involve management of a solid waste under RCRA. Materials that are solid waste under RCRA are potentially subject to RCRA hazardous waste requirements.

In contrast, under title VI of the CAA and its implementing regulations, "reclaim" is a more precise term, requiring the reclaimed refrigerant to meet regulatory specifications based on AHRI Standard 700–2016, while "recycle" means to extract refrigerant from an appliance and clean it for reuse in equipment of the same owner without meeting all of the CAA requirements for reclamation. See those definitions in 40 CFR 82.152. Similarly, under the AIM Act, "reclaim; reclamation" is defined in subsection (b)(9) of the Act, and that definition refers to the purity

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[113] EPA 1980, *Background Document for the Hazardous Waste Characteristic of Ignitability*, May 2, 1980, p.7 *https://www.epa.gov/hw/background-document-hazardous-waste-characteristic-ignitability*.

standards under AHRI Standard 700–2016 (or an appropriate successor standard adopted by EPA Administrator) and the verification of purity using, at a minimum, the analytical methodology described in that standard. “Recycle” is not defined in the AIM Act.

To avoid confusion when discussing what regulatory requirements apply to ignitable spent refrigerant, for the purposes of the final RCRA alternative standards, EPA is using the term “recycle for reuse” as defined at 40 CFR 266.601 to mean to process an ignitable spent refrigerant to remove contamination and prepare it to be used again. This umbrella term includes reclaiming ignitable spent refrigerants as defined in the context of the RCRA regulations at 40 CFR 261.1(c), and either reclaiming or recycling refrigerants as defined in 40 CFR 82.152. “Recycle for reuse” would not include recycling that involves burning for energy recovery or use in a manner constituting disposal (use in or on the land) as defined in 40 CFR 261.2(c), or sham recycling as defined in 40 CFR 261.2(g).

2. Background

On February 13, 1991, EPA promulgated an interim final rule excluding spent chlorofluorocarbon (CFC) refrigerants from the definition of hazardous waste under RCRA when recycled for reuse (56 FR 5910). EPA was concerned that subjecting used CFC refrigerants to RCRA hazardous waste regulations would result in increased venting of these refrigerants, resulting in increased levels of ODS in the stratosphere. As described above in section III.C., EPA promulgated a series of rules implementing provisions under CAA title VI to phase out class I and class II ODS, including CFCs used as refrigerants, and establishing standards applicable to the use, disposal, and recycling of ODS refrigerants and their substitutes.

Some of these acceptable substitutes are flammable and likely to exhibit the hazardous waste characteristic of ignitability found in 40 CFR 261.21.[114] As described in section I.B., ASHRAE Standard 34–2022 assigns a safety group classification for each refrigerant which consists of two alphanumeric characters (*e.g.*, A2 or B1). The capital letter indicates the toxicity class ("A" for lower toxicity), and the numeral denotes the flammability. ASHRAE recognizes three classifications and one subclass for refrigerant flammability. The three main flammability classifications are Class 1, for refrigerants that do not propagate a flame when tested as per the ASHRAE 34 standard, "Designation and Safety Classification of Refrigerants;" Class 2, for refrigerants of lower flammability; and Class 3, for highly flammable refrigerants, such as certain hydrocarbon refrigerants. ASHRAE recently updated the safety classification matrix to include a new flammability subclass 2L, for flammability Class 2 refrigerants that burn very slowly.[115] Since 2010, EPA's SNAP program has listed a number of flammable substitute refrigerants that have ASHRAE safety classifications of A3 (higher flammability, lower toxicity refrigerants such as propane or isobutane) or A2L (lower flammability, lower toxicity refrigerants such as HFC-32 or HFO-1234yf).

The standard for flammability under ASHRAE Standard 34-2022 does not correspond precisely with the RCRA standards for ignitability found in 40 CFR 261.21, but in general,

[114] "Flammability" as identified by the ASHRAE standards and "ignitability" as identified by the RCRA 40 CFR 261.21 standard are both intended to capture the potential for a substance to cause fires. However, since the methodology used under these two systems differs, EPA is using "flammability" when describing the ASHRAE standard and "ignitability" when describing wastes that are regulated under RCRA when they meet the ignitable characteristic in § 261.21 and therefore are subject to hazardous waste management requirements. In general, a flammable substance would be presumed to be also ignitable under RCRA unless testing were to demonstrate otherwise.

[115] ASHRAE Fact Sheet *Update on New Refrigerants Designations and Safety Classification* November 2022. *https://www.ashrae.org/file%20library/technical%20resources/bookstore/factsheet_ashrae_english_november2022.pdf*.

refrigerants with a flammability Class of 2 or 3 are expected to be ignitable under RCRA. Spent refrigerants with a flammability class of 2L may or may not be ignitable hazardous waste, depending on the specific chemical(s) used in the refrigerant and contamination of the refrigerant during use. Note that even refrigerants that do not exhibit the RCRA characteristic of ignitability as a virgin material could become ignitable with use, especially if contaminated with oil or other lubricants, posing a risk of fire if mismanaged.[116] Similarly, the flash point of a refrigerant that is a blend of two or more chemicals can change if there is a leak during operation or during recovery and storage, when the refrigerant from multiple appliances is combined, or if the recovery process is incomplete, potentially changing the hazardous waste characteristic of the spent refrigerant when collected.

It should be noted that these ignitable spent refrigerant substitutes do not fall under the 40 CFR 261.4(b)(12) RCRA exclusion for refrigerants, since that exclusion is limited to CFC refrigerants. [117] The applicability of RCRA to flammable refrigerants is also discussed in the 2016 SNAP final rule (81 FR at 86799–86800, December 1, 2016). Consistent with that discussion, EPA does not consider incidental releases of spent refrigerant that occur during the service, and repair of appliances subject to CAA section 608 to be disposal of a hazardous waste under RCRA. However, ignitable spent refrigerant from commercial and industrial appliances (*i.e.*, non-household appliances) would be classified as hazardous waste and would need to be managed under the applicable RCRA regulations (40 CFR parts 260 through 270) when recovered (*i.e.*, removed from an appliance and stored in an external container) or disposed of.

[116] S N Kopylov et al 2019 IOP Conf. Ser.: Earth Environ. Sci. 272 022064; *https://iopscience.iop.org/article/10.1088/1755-1315/272/2/022064*.

[117] EPA did not reopen the original CFC refrigerant recycling exclusion and did not request comment on 40 CFR 261.4(b)(12).

These requirements would include RCRA hazardous waste generator notification and on-site accumulation standards, emergency preparedness and other requirements, hazardous waste manifest and transportation requirements for the ignitable spent refrigerant, and RCRA permit requirements for refrigerant recyclers that store the refrigerant prior to recycling, unless the refrigerants are recycled for reuse under part 266, subpart Q as described later in this section.

3. Final alternative RCRA standards for ignitable spent refrigerants being recycled for reuse

Similar to EPA's concerns expressed in the 1991 rulemaking establishing the CFC refrigerant recycling exclusion, EPA is concerned that applying full RCRA hazardous waste requirements to the substitute refrigerants that exhibit the hazardous characteristic of ignitability would discourage recycling and could result in an increase in releases of ignitable refrigerants, including HFC ignitable refrigerants, contrary to the goals of RCRA. We separately note that such releases would also be contrary to one of the purposes of regulations under subsection (h)(1) of the AIM Act, which is to minimize releases of HFCs from equipment. Moreover, inadvertently incentivizing releases of refrigerants would be contrary to RCRA section 3004(n), which requires EPA to control air emissions from hazardous waste management, as may be necessary to protect human health and the environment. Finally, the current requirements for recovery of refrigerants under the CAA section 608 rules are more stringent than the recycling requirements under the RCRA 40 CFR 261.6 recyclable materials rules and help ensure that the ignitable spent refrigerants are legitimately recycled for reuse, as well as address the flammability risks posed by ignitable spent refrigerants.

For the reasons stated above, EPA is finalizing standards under 40 CFR part 266, subpart Q applicable to certain ignitable spent refrigerants that are recycled for reuse that would apply instead of the full RCRA Subtitle C hazardous waste requirements. The purpose of these standards is to help reduce emissions of ignitable spent refrigerants to the lowest achievable level by maximizing the recovery and safe recycling of such refrigerants during the service, repair, and disposal of appliances.

EPA proposed that 40 CFR part 266, subpart Q RCRA alternative standards would apply to HFCs and substitutes that are lower flammability (i.e., that do not belong to flammability Class 3). In this final action, consistent with the proposal, EPA is keeping the applicability of the alternative standards to the lower flammability substitutes because of the lower risk of fire from the collection and recycling for reuse of these refrigerants, and the greater market value of these refrigerants, which supports the conclusion that these spent refrigerants will be recycled for reuse and not stockpiled, mismanaged, or abandoned. In the context of hazardous secondary materials recycled under RCRA, EPA has found that a low market value for a reclaimed product can increase the likelihood of mismanagement and abandonment occurring during hazardous waste recycling activities.[118]

Lower flammability spent refrigerant means a spent refrigerant that is not considered highly flammable. Highly flammable refrigerants include, but is not limited to the following chemicals: butane, isobutane, methane, propane, and/or propylene. EPA did not receive comments on the proposed definition of "lower flammability spent refrigerant." However, the Agency is modifying the definition in this final rule to provide examples of refrigerants that are considered highly flammable.

[118] U.S. EPA, A Study of the Potential Effects of Market Forces on the Management of Hazardous Secondary Materials Intended for Recycling, November 2006, available at *https://www.regulations.gov/document/EPA-1HQ-RCRA-2002-0031-0358*.

a. Comments on the RCRA alternative standards and changes made in response to comments

EPA received seventeen public comments on the proposed RCRA alternative standards. All comments were supportive of EPA finalizing alternative standards that are specifically designed for ignitable spent refrigerant being recycled for reuse instead of imposing the standard RCRA Subtitle C hazardous waste requirements on these waste streams. Accordingly, EPA is finalizing these standards largely as proposed.

However, several comments raised concerns regarding applying the speculative accumulation limit to storage of ignitable spent refrigerants at reclamation facilities.[119] As noted in the proposal (88 FR 72275), restrictions on speculative accumulation have been an important element of the RCRA hazardous waste recycling regulations since they were originally promulgated on January 4, 1985 (50 FR 634 through 637). According to this regulatory provision, the person accumulating the hazardous secondary material must demonstrate that the material is recyclable and that during a calendar year (beginning January 1) the amount of such material that is recycled or transferred to a different site for recycling is at least 75 percent by weight or volume of the amount of the hazardous secondary material present at the beginning of the calendar year (January 1).

Comment: Commenters stated that requiring reclaimers to process 75 percent of these refrigerants within one year would be very challenging for most reclaimers. In particular, commenters noted that due to a very small initial installed equipment base and low equipment service rates in the first years of the HFC phasedown, limiting the accumulation period to a one

[119] See comment numbers EPA-HQ-OAR-2022-0606-0084, EPA-HQ-OAR-2022-0606-0085, EPA-HQ-OAR-2022-0606-0102, EPA-HQ-OAR-2022-0606-0109, EPA-HQ-OAR-2022-0606-0111, EPA-HQ-OAR-2022-0606-0113, and EPA-HQ-OAR-2022-0606-0159 in the docket.

year maximum would require processing of extremely small quantities which would be an inefficient use of reclaimer resources.

Response: EPA notes that there is an existing provision at 40 CFR 260.31(a) that allows facilities to petition EPA for an extension of the speculative accumulation time limit if the applicant demonstrates that sufficient amounts of the material will be recycled or transferred for recycling in the following year. Applicants must follow the procedures in 40 CFR 260.33.

However, given the fact the potential limitations in the quantities available to be processed would be an industry-wide issue during the first years of the HFC phasedown, EPA agrees with the commenters that a delayed compliance date for the speculative accumulation requirement is warranted. This delayed compliance date is a more efficient use of resources than requiring each affected facility to petition the Agency for an extension and would allow time to build up supply to make reclamation more economical for the reclamation facility.

Accordingly, EPA is delaying the compliance date for the speculative accumulation time limit until the calendar year 2029. Up until January 1, 2029, reclamation facilities may accumulate ignitable spent refrigerants without recycling them for reuse as long as the other requirements of the alternative RCRA standards are met. The speculative accumulation limits would then begin to apply during calendar year 2029. In other words, by December 31, 2029, reclaimers must reclaim 75 percent of the inventory of ignitable spent refrigerant that was present on-site on January 1, 2029. If they will be unable to meet this deadline, they may submit a petition for an extension under 40 CFR 260.31 using the procedures in 40 CFR 260.33, or they must manage their inventory of ignitable spent refrigerant as hazardous waste.

Comment: One commenter requested clarification on how the new RCRA alternative standards would apply to persons who receive refrigerants from off-site but do not recycle them for reuse.[120]

Response: EPA agrees that if a facility receives ignitable spent refrigerant but does not recycle it for reuse, then it should not be subject to the proposed standard that requires off-site facilities to maintain certification by EPA under § 82.164 (see 88 FR 72275). However, if such a facility stores the ignitable spent refrigerant for more than ten (10) days in the normal course of transportation[121], the same issues regarding speculative accumulation and the risks of fire and explosions that EPA identified in the proposal concerning off-site facilities receiving and accumulating ignitable spent refrigerants would still apply (see 88 FR 72275-72276). Thus, in the final rule EPA is including clarifying language that explains that persons who receive ignitable spent refrigerants from off-site, and are not a transfer facility that stores the refrigerants for less than ten (10) days before sending the refrigerant to another site to be recycled for reuse must: (1) meet the emergency preparedness and response requirements of 40 CFR part 261, subpart M; and (2) not speculatively accumulate the ignitable spent refrigerant per § 261.1(c). This could include those in the reverse supply chain (*e.g.*, distributors or wholesalers) or final processors who receive disposable cylinders and remove heels and consolidate them before discarding the cylinder (see section IV.G.1).

Comment: Finally, one commenter suggested a number of technical corrections and editorial clarifications to the proposed regulatory language for the alternative RCRA standards

[120] See comment number EPA-HQ-OAR-2022-0606-0152 in the docket.
[121] Facilities that store less than ten days in the normal course of transportation are considered to be transfer facilities as defined in 40 CFR 260.10 and are generally not subject to RCRA requirements. See 40 CFR 263.12.

including a suggestion that EPA remove the term "alternative", since the new requirements are not optional.[122]

Response: EPA has made revisions to the language in response to these suggestions. In regards the comment requesting EPA remove the description of the new RCRA standards as "alternative", EPA agrees with the comment that they are not optional for persons who wish to recycle ignitable spent refrigerant for reuse. However, the new standards do provide an alternative to the requirements for hazardous waste disposal in found in 40 CFR parts 262-270, and the term was used extensively in the proposed rule and communications materials. Thus EPA is maintaining the description of the new 40 CFR part 266, subpart Q as "alternative standards" to distinguish them from the RCRA hazardous waste disposal standards, but has removed the term from the Subpart Q standards themselves. For more information on public comments on the proposed RCRA alternative standards, and EPA's responses, please see *RCRA Alternative Standards for Ignitable Spent Refrigerants: Response to Comments Document* available in the docket.

b. Scope of the final RCRA alternative standards

The 40 CFR part 266, subpart Q RCRA alternative standards apply to HFCs and substitutes that do not belong to flammability Class 3. Class 3 refrigerants are highly flammable refrigerants that include, but are not limited to, any of the following chemicals: butane, isobutane, methane, propane, and/or propylene. The alternative standards are limited to lower flammability substitutes (Class 1, 2 and 2L)[123] because of the lower risk of fire from the

[122] See comment number EPA-HQ-OAR-2022-0606-0091 in the docket.

[123] Class 1 refrigerants are nonflammable and generally not expected to be ignitable, and therefore not subject to RCRA requirements. However, if a spent Class 1 refrigerant were ignitable due to contamination with oil or other lubricants, it would be subject to the alternative RCRA standards.

collection and recycling for reuse of these refrigerants, and the greater market value of these refrigerants, which supports the conclusion that these spent refrigerants will be recycled for reuse and not stockpiled, mismanaged, or abandoned. In the context of hazardous waste recycled under RCRA, EPA has found that a low market value for a reclaimed product can increase the likelihood of mismanagement and abandonment occurring during hazardous waste recycling activities.

EPA did not receive any comments on the proposed definition of "lower flammability spent refrigerant" but, in order to provide greater clarity and simplify implementation, in lieu of referring to the ANSI/AHRAE standard, EPA is including in the regulatory definition the list of specific chemicals that are considered Class 3 "highly flammable" refrigerant and therefore are not lower flammability refrigerants.

c. RCRA alternative standard requirements

The specific standards EPA is finalizing for ignitable spent refrigerant being recycled for reuse for further use in equipment of the same owner, or by the owner of the recovery equipment in compliance with MVAC standards in 40 CFR part 82, subpart B, are (1) the ignitable spent refrigerants are recovered (*i.e.*, removed from an appliance and stored in an external container) and/or recycled for reuse using equipment that is certified for that type of refrigerant under 40 CFR 82.36 or 40 CFR 82.158; and (2) the ignitable spent refrigerants are not speculatively accumulated as defined in 40 CFR 261.1(c).

The specific standards that EPA is finalizing for facilities receiving refrigerant from off-site to be recycled for reuse are (1) the reclaimer must maintain certification by EPA under 40 CFR 82.164; (2) the facility must meet the applicable emergency preparedness and response requirements of 40 CFR part 261 subpart M, and (3) the ignitable spent refrigerants must not be speculatively accumulated as defined in 40 CFR 261.1(c). These requirements are included as part of the RCRA alternative standard in order to ensure that the ignitable spent refrigerant is legitimately recycled for reuse in a way that is protective of human health and the environment. For facilities that receive ignitable spent refrigerant from off-site and store the refrigerant for more than ten days and then send the refrigerant on to a reclaimer to be recycled for reuse: (1) the facility must meet the applicable emergency preparedness and response requirements of 40 CFR part 261 subpart M, and (2) the ignitable spent refrigerants must not be speculatively accumulated as defined in 40 CFR 261.1(c).

The requirement that the recovery and/or recycling equipment be certified for that type of refrigerant and appliance under 40 CFR 82.36 (for MVAC systems), or 40 CFR 82.158 (for recycling for reuse in appliances by the same owner) specifically addresses the ignitability hazard during refrigerant recovery and recycling for reuse at MVAC recycling operations in compliance with 40 CFR part 82, subpart B, or for recycling for reuse in appliances by the same owner. In particular, appendix B4 to subpart F of 40 CFR part 82—Performance and Safety of Flammable Refrigerant Recovery and/or Recycling Equipment requires all recovery and/or recycling equipment to be tested to meet standards for the test apparatus, test gas mixtures, sampling procedures, analytical techniques, and equipment construction that will be used to determine the performance and safety of refrigerant recovery.

The requirement that the spent refrigerant regulated under the new alternative standards not be speculatively accumulated per 40 CFR 261.1(c) will help prevent over-accumulation, mismanagement, and abandonment of the spent refrigerant. Restrictions on speculative accumulation have been an important element of the RCRA hazardous waste recycling regulations since they were originally promulgated on January 4, 1985 (50 FR 634 through 637).

According to this regulatory provision, hazardous secondary materials as defined in 40 CFR 260.10 (which would include ignitable spent refrigerants) are accumulated speculatively if the person accumulating them cannot demonstrate that the material is potentially recyclable. Further, the person accumulating the hazardous secondary material must demonstrate that during a calendar year (beginning January 1) the amount of such material that is recycled or transferred to a different site for recycling is at least 75 percent by weight or volume of the amount of the hazardous secondary material present at the beginning of the calendar year (January 1). Hazardous secondary materials to be recycled must be placed in a storage unit with a label indicating the first date that the material began to be accumulated, or the accumulation period must be documented through an inventory log or other appropriate method. Otherwise, the hazardous secondary material is considered to be speculatively accumulated and not eligible for the alternative standards in 40 CFR part 266, subpart Q.

Facilities that are unable to make the speculative accumulation time limits do have the option of petitioning EPA for a variance per 40 CFR 260.31(a), using the procedures in 40 CFR 260.33, to extend the timeframe for one year. However, as noted in the discussion of public comments in section IV.H.3.a of the preamble above, EPA is aware that the availability of ignitable spent refrigerants may be limited during the early years of the HFC phasedown, and accordingly is delaying the compliance date for speculative accumulation at reclamation facilities until calendar year 2029. Therefore, up until January 1, 2029, reclamation facilities may accumulate ignitable spent refrigerants without recycling them for reuse as long as the other requirements of the alternative RCRA standards are met. The speculative accumulation limits would then begin to apply during calendar year 2029. In other words, by December 31, 2029, reclaimers must reclaim 75 percent of the inventory of ignitable spent refrigerant that was present on January 1, 2029. If they will be unable to meet this deadline, they may submit a petition for an extension under 40 CFR 260.31 using the procedures in 40 CFR 260.33, or they must manage their inventory of ignitable spent refrigerant as RCRA hazardous waste.

The requirement that facilities receiving refrigerant from off-site to be recycled for reuse maintain certification by EPA under 40 CFR 82.164 helps ensure that the recycler is experienced in proper refrigerant reclamation techniques and will manage the spent refrigerant in a manner that minimizes releases, with an explicit limit under the CAA section 608 rules of no more than 1.5 percent of the refrigerant released during the reclamation process (see 40 CFR 82.164(a)(3)). The certification requirement also helps with the transparency of the RCRA alternative standard since the list of EPA-certified refrigerant reclaimers is publicly available on EPA's website.[124] In addition, these facilities are certified reclaimers under CAA section 608 and must follow recordkeeping and reporting requirements, per 40 CFR 82.164(d) including (1) maintaining records of the names and addresses of persons sending them material for reclamation and the quantity of the material (the combined mass of refrigerant and contaminants) sent to them for reclamation, and (2) reporting annually the quantity of material sent to them for reclamation by refrigerant type, the mass of refrigerant reclaimed by refrigerant type, and the mass of waste products. Finally, EPA-certified refrigerant reclaimers must verify that each batch of reclaimed refrigerant meets the specifications in the regulations (40 CFR 82.164(a)(2)), which helps ensure that the reclamation process is legitimate recycling under the RCRA regulations.

EPA notes that reclaimed refrigerant that does not meet the required specifications would be considered an off-specification commercial chemical product under 40 CFR 261.2(c). If there

[124] EPA- Certified Refrigerant Reclaimers *https://www.epa.gov/section608/epa-certified-refrigerant-reclaimers*. Last updated January 16, 2024.

is an allowable use for the off-spec reclaimed refrigerant and the material is used as an effective substitute for commercial product, it may be exempt from RCRA under the use/reuse provisions of 40 CFR 261.2(e). If the off-spec reclaimed refrigerant goes to further legitimate reclamation, it could also be exempt from RCRA under 40 CFR 261.2(c)(3). If the ignitable off-spec reclaimed refrigerant cannot be either legitimately reused or further reclaimed, it would need to be managed as a hazardous waste.

EPA further notes that persons who reclaim HFCs that are listed as regulated substances under the AIM Act must meet the recordkeeping and reporting requirements as set forth in 40 CFR 84.31(a) and 84.31(i).

Finally, including the requirement that facilities receiving refrigerant to be recycled for reuse, or that store the refrigerant for more than ten days before sending it on to be recycled for reuse, must meet the RCRA standards under 40 CFR part 261, subpart M, Emergency Preparedness and Response for Management of Excluded Hazardous Secondary Materials, addresses the risks posed specifically by ignitable spent refrigerants, which are a subset of hazardous secondary materials. [125] Facilities receiving ignitable spent refrigerants from other parties for recycling for reuse will be subject to this additional emergency preparedness requirement because these third-party recyclers would be receiving ignitable spent refrigerant from multiple sources, and are likely to store greater volumes for longer time periods than companies that recycle for reuse in appliances by the same owner or as part of an MVAC refrigerant recovery and recycling system in compliance with 40 CFR part 82, subpart B. These

[125] Per 40 CFR 260.10, "hazardous secondary materials" means a secondary material (*e.g.*, spent material, by-product, or sludge) that, when discarded, would be identified as hazardous waste under 40 CFR part 261. Ignitable spent refrigerant meets this definition.

emergency preparedness and response requirements include maintaining appropriate emergency equipment on site, having access to alarm systems, maintaining needed aisle space, making arrangements with local emergency authorities, and having a designated emergency coordinator who is responsible for responding in the event of an emergency. This requirement will help protect human health and the environment in the event of a fire or other emergency at the facility. Under the final rule, all facilities receiving ignitable spent refrigerant from off-site, except for ten-day transfer facilities, must meet the emergency preparedness and response requirements under 40 CFR 261.410 and 40 CFR 261.420, which include general personnel training requirements for facilities (40 CFR 261.420(g)).

4. RCRA very small quantity generator wastes

Very Small Quantity Generators (VSQGs) generate less than 100 kg of hazardous waste per month and one kilogram or less per month of acutely hazardous waste and are subject to a limited set of federal RCRA Subtitle C hazardous waste regulations, provided that they comply with the conditions set forth in 40 CFR 262.14. Among those conditions is that the VSQG must either treat and dispose of its hazardous waste in an on-site facility or ensure delivery to an off-site facility listed in 40 CFR 262.14(a)(5). Included in this list is a facility that: (1) beneficially uses or reuses, or legitimately recycles or reclaims its waste; or (2) treats its waste prior to beneficial use or reuse, or legitimate recycling or reclamation.

For ignitable spent refrigerant regulated under the new RCRA alternative standard, EPA is finalizing a conforming change to 40 CFR 262.14(a)(5) to require that these refrigerants be sent to a facility that meets the requirements of 40 CFR part 266, subpart Q if sent off-site for recycling. This revision incorporates into the RCRA regulations a limit to where VSQGs can send ignitable spent refrigerant for recycling for reuse to facilities that meet EPA's certification requirements in 40 CFR 82.164. This revision does not affect refrigerants not subject to the new RCRA alternative standard (*e.g.*, ignitable spent refrigerants that are not sent off-site to be recycled for reuse).

For ignitable spent refrigerant regulated under the new RCRA alternative standard, EPA is making a conforming change to 40 CFR 262.14(a)(5) to require that these refrigerants be sent to a facility that meets the requirements of 40 CFR part 266, subpart Q if sent off-site for recycling. EPA notes that while this change is more stringent than the current RCRA regulations, VSQGs would experience no additional burden since under the CAA section 608 rules, all reclaimers receiving used ODS refrigerants or non-exempt substitute refrigerants from off-site for reclamation must meet EPA's certification requirements in 40 CFR 82.164. This revision does not affect refrigerants not subject to the new RCRA alternative standard (*e.g.*, ignitable spent refrigerants that are not sent off-site to be recycled for reuse).

5. RCRA regulation of exports and imports of certain ignitable spent refrigerants

The RCRA alternative standard is limited to ignitable spent refrigerants that are recycled for reuse in the United States, and it requires that off-site recycling for reuse be performed at an EPA-certified reclaimer per 40 CFR 82.164. Therefore, ignitable spent refrigerants intended for export would not qualify for the RCRA alternative standard, and would instead be regulated under the full RCRA Subtitle C requirements, including the relevant hazardous waste export requirements in 40 CFR part 262, subpart H.

Ignitable spent refrigerants that are imported would qualify for alternative RCRA standards, as long as the imported refrigerants meet the requirements of the RCRA alternative standard, including being recycled for reuse at an EPA-certified reclaimer per 40 CFR 82.164.

This provision does not amend, reopen or otherwise affect any of the requirements for regulated substances established under the AIM Act that are codified at 40 CFR part 84, subpart A.

6. Applicability of alternative standard in RCRA-authorized states

Under section 3006 of RCRA, EPA may authorize a state hazardous waste program to operate in lieu of the federal program within the state. Following authorization, EPA maintains its enforcement authorities, although authorized states have primary enforcement responsibility for their authorized programs. The standards and requirements for state authorization are found in Part 271.

Prior to the enactment of the HSWA, an authorized state hazardous waste program operated entirely in lieu of the federal program in that state. The federal requirements no longer applied in the authorized state, and EPA could not issue permits for any facilities in that state. When new, more stringent or broader federal requirements were promulgated, the state was obligated to adopt equivalent authorities under state law within specified time frames. However, new requirements did not take effect in an authorized state until the state adopted such equivalent authorities, and these requirements did not become part of the authorized program enforceable by EPA until EPA authorized them.

In contrast, with the enactment of RCRA section 3006(g), which was added by HSWA, new federal requirements and prohibitions imposed pursuant to HSWA authority take effect in authorized states at the same time that they take effect in unauthorized states. EPA is directed by section 3006(g) to implement HSWA-based requirements and prohibitions in authorized states until EPA authorizes equivalent state authorities. While states must still adopt state-law equivalents to HSWA-based requirements and prohibitions to retain final authorization, until the states do so, and EPA authorizes the state-law equivalents, EPA implements and enforces these provisions in authorized states.

Authorized states are required to modify their programs when EPA promulgates federal requirements that are more stringent or broader in scope than existing federal requirements. RCRA section 3009 allows the states to impose standards more stringent than those in the federal program (see also 40 CFR 271.1). If EPA promulgates a federal requirement that is less stringent or narrower in scope than an existing requirement or of equivalent stringency, authorized states may, but are not required to, adopt a new equivalent requirement regardless of whether or not it is promulgated under HSWA authority.

7. Effect on state authorization

The RCRA regulations described in this notice of final rulemaking are promulgated under the authority of HSWA and are more stringent than the existing federal regulations. Thus, the standards will be applicable on the rule's effective date in all states and will be implemented and enforced by EPA until the states receive authorization. These RCRA regulations adds a new subpart Q to 40 CFR part 266 *Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities,* and it is being finalized under the authority of HSWA due to its purpose of reducing air emissions from the management of ignitable spent refrigerants, in accordance with EPA's mandate to control air emissions from hazardous waste management, as may be necessary to protect human health and the environment, per RCRA section 3004(n), which was promulgated under HSWA. In addition, the changes to the VSQG Regulations in 40 CFR 262.14 are being promulgated under RCRA section 3001(d)(4), also a HSWA provision.

The final alternative standard establishes a "cradle-to-cradle" management system for ignitable spent refrigerants being recycled for reuse and includes requirements that are more stringent than the current applicable RCRA recycling requirements in 40 CFR 261.6(c), which exempts the recycling process itself from RCRA regulation. This final management system includes the requirement that refrigerant be recovered and/or recycled for reuse in appliances by the same owner using equipment that is certified for that type of refrigerant and appliance under 40 CFR 82.36 or 82.158, and that the recovered refrigerant sent off-site to be recycled for reuse at a facility certified by EPA under 40 CFR 82.164. Both of these provisions are more stringent that the existing RCRA recycling requirements. In addition, the revisions to the VSQG regulations in 40 CFR 262.14 limit where VSQGs can send ignitable spent refrigerant for recycling for reuse to facilities that meet EPA's certification requirements in 40 CFR 82.164 and are more stringent than the current standard. These certifications in 40 CFR 82.164 involve a number of requirements for reclamation that are more stringent than those under the RCRA hazardous waste program, including an explicit limit of no more than 1.5 percent of the refrigerant released during the reclamation process (see 40 CFR 82.164(a)(3)). In addition, these certified reclaimers must follow recordkeeping and reporting requirements, per 40 CFR 82.164(d) including (1) maintaining records of the names and addresses of persons sending them material for reclamation and the quantity of the material (the combined mass of refrigerant and contaminants) sent to them for reclamation, and (2) reporting annually the quantity of material sent to them for reclamation by refrigerant type, the mass of refrigerant reclaimed by refrigerant type, and the mass of waste products. Finally, EPA-certified refrigerant reclaimers must verify that each batch of reclaimed refrigerant meets the specifications in the regulations (40 CFR 82.164(a)(2)), which helps ensure that the reclamation process is legitimate recycling under the

RCRA regulations. These alternative standards are designed to function as system that is better tailored to the reclamation of ignitable spent refrigerants than the RCRA requirements in 40 CFR 262-270, and when considered as a whole are more stringent when compared to the previously applicable RCRA recycling requirements.

Moreover, as stated above, authorized states are required to modify their programs when EPA promulgates federal regulations that are more stringent or broader in scope than the authorized state regulations. Because the revisions in this rule are considered to be more stringent than the existing federal requirements, authorized states must modify their programs to adopt regulations equivalent to the provisions contained in this final RCRA rule.

I. MVAC servicing and reprocessed material

EPA did not propose, and therefore is not establishing requirements focused on implementing subsection (h)(2)(B) for MVAC servicing facilities that currently reclaim or recycle recovered MVAC refrigerant in this action. As stated at proposal, EPA understands that under current industry practices, a variety of things might occur once refrigerant has been recovered from an MVAC system. For example, in some situations, MVAC servicing facilities recover refrigerant from the MVAC, recycle it consistent with EPA's regulations under CAA section 609 and return the recycled refrigerant to the same MVAC for continued use by the same owner.[126] In other circumstances, however, EPA understands that the recovered MVAC refrigerant is recycled and used in servicing a different MVAC system with a different owner (*e.g.*, to charge or recharge such a system), thereby in effect selling or transferring the refrigerant to a new owner. See 40 CFR 82.34(d)(2). Additionally, the Agency understands that there are

[126] Another example of an instance where there is no change in ownership is the off-site servicing and recharge of MVAC systems for a fleet of trucks that are owned by the same company.

circumstances where refrigerant recovered from MVAC systems is reclaimed before it is reused or sold or transferred to a new owner.

The servicing and repair of MVAC systems with HFCs and HFC substitutes (*e.g.*, HFO-1234yf and R-744 (CO_2)) have long been subject to certain requirements that are separate from those that apply for the servicing and repair of stationary appliances. Regulations under CAA section 609 require that section 609-certified technicians use equipment approved pursuant to the standards at 40 CFR 82.36 to service and repair MVAC systems. Under those existing regulations, recovered refrigerant can either be recycled on-site or off-site using approved equipment designed to both recover and recycle refrigerant certified to meet SAE J2099.[127] SAE J2099 establishes the minimum level of refrigerant purity (*e.g.*, 98 percent for HFO-1234yf) required for the certification of on-site recovery and recycling machines per SAE J2843 and SAE J2788. Refrigerant from reclamation facilities that is used for the purpose of recharging MVACs must be at or above the standard of purity (*i.e.*, 99.5 percent) level defined in AHRI Standard 700, and EPA understands that such reclamation typically occurs off-site. See 40 CFR 82.32(e)(2).

Due to the longstanding practice of on-site recycling of single-component MVAC refrigerants, some industry stakeholders[128] questioned the need to reclaim recovered MVAC refrigerant to meet the purity described in AHRI Standard 700-2016 as specified in the definition of the terms “reclaim” and “reclamation” in subsection (b)(9) of the Act. They noted that equipment certified to meet SAE J2099 are rated to clean and separate material in contaminated

[127] SAE International, 2012. SAE J2099: Standard of Purity for Recycled R-134a (HFC-134a) and R-1234yf (HFO-1234yf) for Use in Mobile Air- conditioning Systems.
[128] March 6, 2023, EPA meeting with Mobile Air Climate Systems (MACS) Association and SAE International. Meeting materials available in the docket (EPA-HQ-OAR-2022-0606) for this rulemaking at *https://www.regulations.gov*.

refrigerant to a 98 percent purity level, which provides the same level of performance and durability as virgin refrigerant for purposes of use in MVACs. They also pointed out the ambiguity in the phrase "(or an appropriate successor standard adopted by the Administrator)" in definition of "reclaim" and "reclamation" in the AIM Act. While there may be a variety of situations that could lead to the adoption of a successor standard by the Administrator within the meaning of subsection (b)(9), in EPA's view one such circumstance would be if AHRI published a subsequent standard or addendum regarding the reprocessing of a recovered regulated substance to a specified purity standard and the analytical methodology to verify the purity of that regulated substance, and that standard were adopted by the Administrator as a successor standard.

EPA is aware that AHRI is in consultations with SAE International, the Mobile Air Climate Systems (MACS), and other industry stakeholders to develop a standard (or update an existing standard) that may be more appropriate for MVAC servicing than the AHRI Standard 700–2016.[129] If such a standard is finalized, EPA intends to review it, and any supporting information, and consider what implications it might have for potential approaches that the Agency might consider in future rulemakings to implement subsection (h)(2)(B) for MVAC systems. Additionally, the Agency could consider establishing its own purity standard and analytical methodology for verification of the purity of recovered regulated substances, as well as specifying minimum equipment requirements for MVAC systems under subsection (h). Among other things, such a standard could be based on consideration of input from stakeholders

[129] Letter to EPA from AHRI, Alliance for Automotive Innovation, Alliance for Responsible Atmospheric Policy, and MACS dated June 9, 2023. Available in the docket (EPA-HQ-OAR-2022-0606) for this rulemaking at *https://www.regulations.gov*.

and consensus standards bodies. EPA could consider adopting any such standard in a future rulemaking. In light of the time needed to develop such standards (whether developed by EPA or standard setting organizations) and for EPA to consider whether they are appropriate for the Agency to adopt as successor standards in the context of subsection (h), as well as the implications that such standards might have on the regulations that EPA might propose to implement subsection (h)(2)(B) for MVAC systems, EPA did not propose such regulations. Instead, EPA intends to issue proposed regulations for this sector at a later date, once it has additional clarity on the development of such a successor standard and its likely content. Additionally, the Agency may need to consider potential approaches for the recycling and/or reclaiming of MVAC refrigerant blends, which may include regulated substances and/or substitutes for regulated substances.

Comment: One commenter stated that they support the AIM Act and engaged early with EPA to share their ongoing process for "phasing out HFCs." The commenter stated that their members fully support the goals of phasing out of HFCs their vehicles sold in the United States, and that their member companies have been undergoing this transition for many years.

Response: EPA acknowledges these comments and their support of the AIM Act. To the extent that these comments relate to EPA actions under other provisions of the AIM Act, such as the HFC phasedown or restrictions under subsection (i) of the AIM Act, they are beyond the scope of this rulemaking and thus require no further response.

Comment: Three commenters supported the Agency's decision to not issue requirements under subsection (h)(2)(B) for MVAC servicing facilities. One commenter noted that the MVAC sector is unique, with regulations under 40 CFR part 82, subpart B allowing recovered and recycled refrigerant to be returned to the same MVAC for continued use by the same owner or used to service a different MVAC system. Another commenter stated that implementing requirements under the AIM Act for the MVAC sector or requiring the return of refrigerant heel in disposable cylinders to reclaimers would have a significant cost impact with limited environmental benefits. The commenter further stated that SAE standards already require section 609-certified technicians to recover the refrigerant heel in disposable cylinders and that refrigerant heel amounts are less than one pound under SAE J2788 standards specifications performed in laboratory testing.

Response: EPA acknowledges these comments. EPA did not propose and is not finalizing requirements under AIM subsection (h)(2)(B) for MVAC servicing facilities that currently reclaim or recycle recovered MVAC refrigerant in this rulemaking. Thus, EPA need not further address the points in these comments related to such requirements.

Comment: A few commenters expressed support of EPA's decision to give time for SAE, AHRI, MACS, other industry stakeholders, and/or other entities to consider a new purity standard for MVAC systems. One commenter noted that the "appropriate successor standard" provision under the AIM Act would allow the current practice of onsite recycling of MVAC refrigerant prior to transfer of ownership to continue through either a modified version of AHRI 700 or more preferably, an updated version of SAE J2099. Another commenter stated that they supported the Agency's decision to defer to AHRI and SAE to develop an updated standard or standards and mentioned that AHRI has a long track record of developing robust industry standards and is best poised to update Standard 700-2016. One commenter stated that SAE is currently reviewing and revising SAE J2099 to address concerns in the auto sector on using purity based refrigerant compositions rather than performance-based metrics as a decision on whether a vehicle must be recovered, or if the material can be recycled.

Response: EPA acknowledges these comments and as noted previously, EPA did not propose and is not finalizing requirements under AIM subsection (h)(2)(B) for MVAC servicing facilities that currently reclaim or recycle recovered MVAC refrigerant in this rulemaking. Thus, EPA need not further address the points in these comments related to such requirements. Further, as explained earlier in this section, EPA intends to consider issuing such proposed regulations for this sector at a later date. The Agency reminds stakeholders that the regulatory provisions under CAA sections 608 and 609 continue to apply and cover both servicing and end-of-life for MVAC systems.

Comment: One commenter stated that EPA should require 100 percent reclaimed refrigerant in all small containers of MVAC refrigerant by 2027, consistent with CARB's Small Container of Automotive Refrigerant regulation. The commenter stated that after conversations will stakeholders, they anticipate that there will be enough supply of reclaimed HFC-134a to meet demand for the refrigerant.

Response: EPA responds that the Agency did not propose and is not finalizing use of 100 percent reclaimed refrigerant in small containers of MVAC refrigerant. For reasons explained in section IV.E, the requirements related to the use of reclaimed refrigerants in the final rule are limited to stationary appliances.

V. How is EPA treating data reported under this rule?

Consistent with EPA's commitment to transparency in program implementation, as well as to proactively encourage compliance, support enforcement of program requirements and enable third-party engagement to complement EPA's enforcement efforts, EPA is finalizing requirements for the treatment and release data that would be collected. EPA is finalizing certain categorical emission data and confidentiality determinations for individual reported data elements that EPA would be collecting through this rulemaking. This action identifies certain information categories that must be submitted to EPA that will be subject to disclosure to the public without further notice because the information has been determined to be either "emission data" under 40 CFR 2.301(a), or the Agency has found that the information does not meet the standard for confidential treatment under Exemption 4 of the Freedom of Information Act (FOIA). EPA has also identified certain other categories of information that may be entitled to confidential treatment. For information EPA is not determining in this rulemaking to be emission data or not otherwise entitled to confidential treatment, EPA will apply the 40 CFR part 2 process for establishing case-by-case confidentiality determinations. As explained further in the following discussion, the emission data and confidentiality determinations in this action are intended to increase the efficiency with which the Agency responds to FOIA requests and to provide consistency in the treatment of the same or similar information. Establishing these determinations through this rulemaking provides predictability for both information requesters and submitters. The emission data and confidentiality determinations in this rule will also increase transparency, as well as supporting compliance with, and enforcement of, the program's requirements.

A. Background on determinations of whether information is entitled to treatment as confidential information

1. Confidential treatment of reported information

Regulated entities that must submit information to EPA frequently claim that some or all of that information is entitled to confidential treatment and therefore exempt from disclosure under Exemption 4 of the FOIA.[130] Exemption 4 exempts from disclosure "trade secrets and commercial or financial information obtained from a person [that is] privileged or confidential."[131] In order for information to meet the requirements of Exemption 4, EPA must find that the information is either: (1) a trade secret, or (2) commercial or financial information that is: (a) obtained from a person, and (b) privileged or confidential.

Generally, when the Agency has information that it intends to disclose publicly that is covered by a claim of confidentiality under FOIA Exemption 4, EPA has a process to make case-by-case or class determinations under 40 CFR part 2 to evaluate whether such information qualifies for confidential treatment under the exemption.[132, 133] In this action, EPA is providing clarity concerning certain categorical emission data and confidentiality determinations for some information that must be submitted to EPA under these requirements. For those determinations, that information would be subject to disclosure to the public without further notice.

The U.S. Supreme Court decision in *Food Marketing Institute* v. *Argus Leader Media,* 139 S. Ct. 2356 (2019) (*Argus Leader*) addresses the meaning of "confidential" within the context of FOIA Exemption 4. The Court held that "[a]t least where commercial or financial information is both customarily and actually treated as private by its owner and provided to the government under an assurance of privacy, the information is 'confidential' within the meaning

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[130] 5 U.S.C. 552(b)(4).
[131] 5 U.S.C. 552(b)(4).
[132] 40 CFR 2.205.
[133] This approach of making categorical determinations for a class of information is a well-established Agency practice. Prior examples of rules where EPA has made such categorical determinations include *Confidentiality Determinations for Data Required Under the Mandatory Greenhouse Gas Reporting Rule and Amendments to Special Rules Governing Certain Information Obtained Under the Clean Air Act* (76 FR 30817)(May 26, 2011); *Control of Air Pollution From New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards* (88 FR 4296) (January 24, 2023); and *Renewable Fuel Standard (RFS) Program: RFS Annual Rules* (87 FR 39600) (July 1, 2002).

of Exemption 4."[134] The Court identified two conditions "that might be required for information communicated to another to be considered confidential."[135] Under the first condition, "information communicated to another remains confidential whenever it is customarily kept private, or at least closely held, by the person imparting it."[136] The second condition provides that "information might be considered confidential only if the party receiving it provides some assurance that it will remain secret." [137] The Court found the first condition necessary for information to be considered confidential within the meaning of Exemption 4, but did not address whether the second condition must also be met.

Following the issuance of the Court's opinion in *Argus Leader*, the U.S. Department of Justice (DOJ) issued guidance concerning the confidentiality prong of Exemption 4, articulating "the newly defined contours of Exemption 4" post- *Argus Leader*.[138] Where the Government provides an express or implied indication to the submitter prior to or at the time the information is submitted to the Government that the Government would publicly disclose the information, then the submitter generally cannot reasonably expect confidentiality of the information upon submission, and the information is not entitled to confidential treatment under Exemption 4.[139] Information will not be kept confidential and will be disclosed publicly if it is determined to not be entitled to confidential treatment in this rule. This is aligned with the Supreme Court's

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[134] *Argus Leader,* 139 S. Ct. at 2366.
[135] *Id.* at 2363.
[136] *Id.* (internal citations omitted).
[137] *Id.* (internal citations omitted).
[138] "Exemption 4 After the Supreme Court's Ruling in Food Marketing Institute v. Argus Leader Media and Accompanying Step-by-Step Guide," Office of Information Policy, U.S. DOJ, (October 4, 2019). Available at: *https://www.justice.gov/oip/exemption-4-after-supreme-courts-ruling-food-marketing-institute-v-argus-leader-media*.
[139] See *id.* ; see also "Step-by-Step Guide for Determining if Commercial or Financial Information Obtained from a Person is Confidential under Exemption 4 of the FOIA," Office of Information Policy, U.S. DOJ, (updated October 7, 2019). Available at: *https://www.justice.gov/oip/step-step-guide-determining-if-commercial-or-financial-information-obtained-person-confidential.*

decision, and the subsequent DOJ guidance that the government's assurances that a submission will be treated as *not* confidential should dictate the expectations of submitters. Based on the finalized determinations, submitters are on notice before they submit any information that EPA has determined that the identified data elements outlined in the tables below, as well as in the memorandum provided in the docket for this action titled *Confidentiality Determinations and Emission Data Designations for Data Elements in the Final Rule*, will not be entitled to confidential treatment upon submission and may be released by the Agency without further notice. As a result, submitters do not have a reasonable expectation that the information will be treated as confidential; rather, they have the reasonable expectation that the information will be disclosed.

As described further below, EPA is making categorical confidentiality determinations for some of the data that will be submitted to EPA because these data contain information that is not entitled to confidential treatment because either: it is not the type of information that submitters customarily keep private or closely held; it is already publicly available; or it is discernible information that is self-evident or readily observable through reverse engineering by a third party.

Comment: One commenter stated that EPA's requirements with respect to confidential data are responsible and appropriate. Another commenter recommended that EPA consider the scope, cost, and effort for the Agency to publish and maintain such information and that EPA should consider modifying its publications to an annual or other basis if the burden of publication becomes too great to maintain.

Response: EPA acknowledges the general support for the proposal. The Agency did consider scope and cost for data collection in the information collection request (ICR) available in the docket of this final rulemaking. As noted above, the Agency is committed to data transparency and intends to maintain and publish (*e.g.*, post on EPA's website) with an appropriate frequency.

Comment: A few commenters discussed the proposed container tracking data elements. One commenter stated that EPA peremptorily proposed to find that certain categorical information is either "emission data" and should be treated as such pursuant to 40 CFR §2.301(a) or that this type of information does not qualify for confidential treatment under Exemption 4 of the FOIA. The commenter further stated that this would treat the covered information as releasable without further notification to the submitter. This commenter disagreed with these proposed determinations and with EPA's proposed conclusion that data elements associated with the proposed tracking system were not the type of information that is customarily closely held or kept private by companies. The commenter also disagreed with EPA's proposed conclusion that this information meets the regulatory definition of "emissions data" within 40 CFR 2.301(a)(2)(i). Another commenter supported the proposed rule's data collection requirements and encouraged EPA to expand the public availability of data on the composition and volumes of refrigerants on the U.S. market, including expanded transparency requirements for virgin producers in order to facilitate EOL fractionation and reclamation.

Response: EPA interprets the first comment to relate to the proposed confidentiality determinations for the data elements related to the container tracking requirements that were included in section V.C of the proposal. As discussed in section I.B, the Agency is not finalizing container tracking requirements at this time and thus is not making final determinations on the confidential treatment of those data elements in this rulemaking. Accordingly, the Agency need not respond to comments regarding the proposed confidentiality determinations for the container tracking system this rulemaking. However, EPA notes that the commenter has presented only general objections to EPA's proposed determinations that these data elements were emissions data or did not qualify for confidential treatment, and the comment did not identify which particular data elements it views as entitled to confidential treatment or not qualifying as emissions data. The comment also did not provide any information to support their assertions that the proposed determinations would result in the "disclosure of much information that is not public"[140] and that would result in harm; moreover, it provided no substantiation to show that this information is customarily treated as confidential. This lack of specificity would impede EPA's effort to evaluate the commenter's concerns with respect to any particular data elements. Insofar as commenters disagree with proposed determinations that information is not entitled to confidential treatment, they should highlight the particular data element or elements where they disagree with the proposed determination and provide information regarding how that data element is customarily and actually treatment by them and by their industry sector to support their assertions. Without such information, EPA is unable to fully assess the commenters' concerns, particularly when the data elements include information where EPA can discern no apparent reason for thinking that the information would typically be treated as confidential by the submitter (e.g., information that is already publicly available or is not generally claimed as confidential by the industry sector). Further, the fact that only one commenter objected to the proposed determinations may indicate that the information is not customarily closely held or kept private.

[140] See comment number EPA-HQ-OAR-2022-0606-0085 at 25.

EPA acknowledges the other commenter's support of the data collection requirements and availability of public data to extent that it is covered in this final rule. Data regarding production is outside the scope of this rule but may already be available at the HFC data hub.[141]

2. Emission data under section 114 of the Clean Air Act

The AIM Act provides that, "[s]ections 113, 114, 304, and 307 of the CAA (42 U.S.C. 7413, 7414, 7604, 7607) shall apply to this section and any rule, rulemaking, or regulation promulgated by the Administrator pursuant to this section as though this section were expressly included in title VI of that Act (42 U.S.C. 7671 *et seq*.)." The CAA states that "[a]ny records, reports or information obtained under [section 114] shall be available to the public."[142] Thus, the CAA begins with a presumption that information submitted to EPA will be available to be disclosed to the public. It then provides a narrow exception to that presumption for information that "would divulge methods or processes entitled to protection as trade secrets." The CAA further narrows this exception by excluding "emission data" from the category of information eligible for confidential treatment. While the CAA does not define "emission data," EPA has done so by regulation at 40 CFR 2.301(a)(2)(i).

EPA releases, on occasion, some of the information submitted under CAA section 114 to parties outside of the Agency of its own volition, through responses to requests submitted under the FOIA,[143] or through civil litigation. Generally, when we have information that we intend to disclose publicly that is covered by a claim of confidentiality under FOIA Exemption 4, EPA has a process to make case-by-case or class determinations under 40 CFR part 2. This process

[141] Available at: *https://www.epa.gov/climate-hfcs-reduction/hfc-data-hub*.
[142] CAA section 114(c); 42 U.S.C. 7414(c).
[143] 5 U.S.C. 552.

includes an evaluation of whether such information is or is not emission data, and whether it otherwise qualifies for confidential treatment under FOIA Exemption 4.[144]

The regulations at 40 CFR 2.301 define emission data to include the following:

> (A) Information necessary to determine the identity, amount, frequency, concentration, or other characteristics (to the extent related to air quality) of any emission which has been emitted by the source (or of any pollutant resulting from any emission by the source), or any combination of the foregoing;
>
> (B) Information necessary to determine the identity, amount, frequency, concentration, or other characteristics (to the extent related to air quality) of the emissions which, under an applicable standard or limitation, the source was authorized to emit (including, to the extent necessary for such purposes, a description of the manner or rate of operation of the source); and
>
> (C) A general description of the location and/or nature of the source to the extent necessary to identify the source and to distinguish it from other sources (including, to the extent necessary for such purposes, a description of the device, installation, or operation constituting the source).

In this action, we are applying the regulatory definition of "emission data" in 40 CFR 2.301(a)(2)(i) and finding that certain categories of source information are not entitled to confidential treatment because they qualify as emission data. By finalizing these determinations, that information is subject to disclosure to the public without further notice. As relevant to the determinations that are being finalized in this action, a "source" for purposes of the definition in

[144] 40 CFR 2.301(a)(2)(i).

40 CFR 2.301 is generally the equipment covered by a regulatory requirement, such as a refrigerant-containing appliance or fire suppression equipment. EPA's broad general definitions of emission data also exclude certain information related to products still in the research and development phase or products not yet on the market except for limited purposes. Thus, for example, 40 CFR 2.301(a)(2)(ii) excludes information related to "any product, method, device, or installation (or any component thereof) designed and intended to be marketed or used commercially but not yet so marketed or used." This specific exclusion from the definition of emission data is limited in time. Data related to this exclusion are not implicated in this rulemaking because data reported under this rule relate to equipment currently in use.

B. Data elements reported to EPA under the leak repair provisions

Consistent with EPA's commitment to transparency in program implementation, EPA has reviewed the data elements in the chronically leaking appliance report and the other ad hoc reports required under the leak repair requirements to see if information under the umbrella of those data elements could be considered entitled to confidential treatment. EPA is treating certain data elements under the leak repair provisions as not entitled to confidential treatment. Tables 2 and 3 outline individual data elements that will not be handled as confidential, emission data, or otherwise not entitled to confidential treatment. Additional information on these determinations is provided in the memorandum titled *Confidentiality Determinations and Emission Data Designations for Data Elements in the Final Rule*, which is available in the docket for this action. There may be additional reasons not to release individual data elements determined to not be entitled to confidential treatment, for example if it is personally identifiable information (PII). The Agency will separately determine whether any data should be withheld from release for reasons other than business confidentiality before data are released.

Table 2. Determination of Confidentiality Status for Data Elements Related to Reports on Chronically Leaking Appliances

Description of data element	Confidentiality status and rationale[a]
Identification information (owner name, facility name, facility address where appliance is located)	No confidential treatment/Emission data
Appliance ID or description (for facilities with multiple appliances)	No confidential treatment/Emission data
Appliance type (comfort cooling, IPR, or commercial refrigeration)	No confidential treatment/Emission data
Refrigerant type	No confidential treatment/Emission data
Full charge of appliance (pounds)	No confidential treatment/Emission data
Annual percent refrigerant loss	No confidential treatment/Emission data
Dates of refrigerant addition	No confidential treatment/Emission data
Amounts of refrigerant added	No confidential treatment/Emission data
Date of last successful follow-up verification test	No confidential treatment/Emission data
Explanation of cause of refrigerant losses (Narrative)	No confidential treatment/Emission data
Description of the repair actions taken (Narrative)	No confidential treatment/Emission data
Whether a retrofit or retirement plan been developed for the appliance, and, if so, the anticipated date of retrofit or retirement	No confidential treatment/Emission data

[a] EPA provides rationale of the confidentiality determination in the memorandum titled *Confidentiality Determinations and Emission Data Designations for Data Elements in the Final Rule*, which is available in the docket (EPA-HQ-OAR-2022-0606) of this rulemaking at *https://www.regulations.gov*.

Table 3. Determination of Confidentiality Status for Data Elements Related to Other Leak Repair Notifications and Extension Requests

Description of data element	Confidentiality status and rationale[a]
<u>Extension of time to complete repairs:</u> Identification and address of the facility; the name of the owner or operator of the appliance; the leak rate; the method used to determine the leak rate and full charge; the date the appliance exceeded the applicable leak rate; the location of leak(s) to the extent determined to date; any repair work that has	No confidential treatment/Emission data

been performed thus far, including the date that work was completed; the reasons why more than 30 days (or 120 days if an industrial process shutdown is required) are needed to complete the repair; and an estimate of when the work will be completed. If the estimated completion date is to be extended, a new estimated date of completion and documentation of the reason for that change must be submitted to EPA within 30 days of identifying that the completion date must be extended.	
Relief from the obligation to retrofit or retire an appliance: The date that the requirement to develop a retrofit or retirement plan was triggered; the leak rate; the method used to determine the leak rate and full charge; the location of the leak(s) identified in the leak inspection; a description of repair work that has been completed; a description of repair work that has not been completed; a description of why the repair was not conducted within the applicable time frame; and a statement signed by an authorized company official that all identified leaks will be repaired and an estimate of when those repairs will be completed (not to exceed one year from date of the plan).	No confidential treatment/Emission data
Extension of time to complete the retrofit or retirement of an appliance: Identification of the appliance; name of the owner or operator; the leak rate; the method used to determine the leak rate and full charge; the date the appliance exceeded the applicable leak rate; the location of leak(s) to the extent determined to date; any repair work that has been finished thus far, including the date that work was finished; a plan to finish the retrofit or retirement of the appliance; the reasons why more than one year is necessary to retrofit or retire the appliance; the date of notification to EPA; and an estimate of when retrofit or retirement work will be finished.	No confidential treatment/Emission data
Notification of exclusion of purged refrigerants that are destroyed from annual leak rate calculations: The identification of the facility and a contact person, including the address and telephone number; a description of the appliance, focusing on aspects relevant to the purging of refrigerant and subsequent destruction; a description of the methods used to determine the quantity of refrigerant sent for destruction and type of records that are being kept by the owners or operators where the appliance is located; the frequency of monitoring and data-recording; and a description of the control device, and its destruction efficiency.	No confidential treatment/Emission data

[a] EPA provides rationale of the confidentiality determination in the memorandum titled *Confidentiality Determinations and Emission Data Designations for Data Elements in the Final Rule*, which is available in the docket (EPA-HQ-OAR-2022-0606) of this rulemaking at *https://www.regulations.gov*.

Information contained within these data elements would categorically not be eligible for confidential treatment because they are either readily apparent or easily ascertainable by an outsider (*e.g.*, owner name, facility name, facility address where appliance is located, appliance ID or description, and appliance type (comfort cooling, IPR, or commercial refrigeration)) or they are considered emission data under 40 CFR 2.301 (*e.g.*, refrigerant type, full charge of appliance, annual percent refrigerant loss, dates of refrigerant addition, amounts of refrigerant added, date of last successful follow-up verification test, explanation of cause of refrigerant losses, repair actions taken, and whether a retrofit or retirement plan been developed for the appliance, and, if so, the anticipated date of retrofit or retirement), or they fit into both categories. Similarly, the items included in a request for an extension for leak repair, request for relief from the obligation to retrofit or retire an appliance, request for an extension of time to complete the retrofit or retirement of an appliance, and a notification of exclusion of purged refrigerants that are destroyed from annual leak rate calculations are likewise not eligible for confidential treatment because this information is readily ascertainable or easily observable by an outside entity, or are considered emission data under 40 CFR 2.301, or both. EPA notes that in these provisions, the source of the emissions would be the regulated equipment, and in the case of all of these notifications these data are necessary to determine the identity, amount, frequency, concentration, or other characteristics (to the extent related to air quality) of any emission which has been emitted by the source and/or information necessary to determine the identity, amount, frequency, concentration, or other characteristics (to the extent related to air quality) of the emissions which, under the leak repair provisions, the source was authorized to emit; and a general description of the location and/or nature of the source to the extent necessary to identify the source and to distinguish it from other sources (including, to the extent necessary for such purposes, a description of the device, installation, or operation constituting the source).

C. Data elements related to fire suppression

As described in section IV.F of this document, EPA is finalizing reporting requirements related to the use of regulated substances in the fire suppression sector. These reporting requirements allow for the monitoring of program implementation and of compliance with the requirements.

EPA is requiring that certain entities in the fire suppression sector provide data to EPA that are similar to the data they already voluntarily collect and report to HEEP as mentioned in section IV.F. Relevant reporting entities covered under this requirement include entities that perform first fill of equipment, service (*e.g.*, recharge) equipment, and/or recycle regulated substances. Relevant entities include companies, such as equipment manufacturers, distributors, agent suppliers or installers. EPA is finalizing that the covered entities report annually: (1) the quantity of each regulated substance held in inventory onsite broken out by recovered, recycled, and virgin; (2) the quantity of material (the combined mass of regulated substance and contaminants) by regulated substance sold and/or recycled for the purpose of installation of new equipment and servicing (*e.g.*, recharge) of fire suppression equipment; (3) the total mass of each regulated substance sold and/or recycled; and (4) the total mass of waste products sent for disposal, along with information about the disposal facility if waste is not processed by the reporting entity. Table 4 presents a more granular description of these data elements, together with their confidentiality status. There may be additional reasons not to release individual data elements determined to not be entitled to confidential treatment, for example if it is PII. The

Agency will separately determine whether any data should be withheld from release for reasons other than business confidentiality before data are released.

EPA has determined that these data are emission data as described at 40 CFR 2.301 because they provide a general description of the location and/or nature of the source to the extent necessary to identify the source and to distinguish it from other sources. As a separate alternative basis, EPA has determined that these data are not entitled to confidential treatment because they are not closely held as confidential by the submitter. Additional information on the rationale for these determinations is provided in a memorandum entitled *Confidentiality Determinations and Emission Data Designations for Data Elements in the Final Rule*, available in the docket for this action.

Table 4. Determination of Confidentiality Status for Data Elements Related to Reports on Fire Suppression

Description of data element	**Confidentiality status and rationale**[a]
Identification information (owner name, facility name, facility address where equipment is located)	No confidential treatment
Quantity of material (the combined mass of regulated substance and contaminants) by regulated substance sold, recovered, recycled, and virgin for the purpose of installation of new equipment and servicing of fire suppression equipment	No confidential treatment
Total mass of each regulated substance sold, recovered, recycled, and virgin	No confidential treatment
Total mass of waste products sent for disposal, along with information about the disposal facility if waste is not processed by the reporting entity	No confidential treatment
[a] EPA provides rationale of the confidentiality determination in the memorandum titled *Confidentiality Determinations and Emission Data Designations for Data Elements in the Final Rule*, which is available in the docket (EPA-HQ-OAR-2022-0606) of this rulemaking at *https://www.regulations.gov*.	

VI. What are the costs and benefits of this action?

A. Background

EPA is providing information on the costs and benefits for the provisions related to managing regulated substances and their substitutes in this rule. The analyses, presented in the *Analysis of the Economic Impact and Benefits of the Final Rule: Management of Certain Hydrofluorocarbons and Substitutes Under Subsection (h) of the American Innovation and Manufacturing Act of 2020* TSD and the RIA addendum, are contained in the docket to this rule and are intended to provide the public with information on the relevant costs and benefits of this action and to comply with EOs. The RIA addendum includes estimates of the SC-HFCs in order to quantify climate benefits, for the purpose of providing useful information to the public and to comply with E.O. 12866. Although EPA is using the social costs of HFCs for purposes of that assessment, this action does not rely on these estimates as a record basis for the Agency action, and EPA would reach the conclusions even in the absence of the social costs of HFCs.

The climate benefits and compliance costs stemming from this final rule include those related to: 1) the provisions on leak repair, leak detection, ALD systems, and recordkeeping and reporting related to these provisions; 2) the amendments to the RCRA hazardous waste regulations; 3) requirements regarding the management of disposable cylinders for HFCs; 4) requiring use of reclaimed HFCs in the servicing of certain types of refrigerant-containing equipment, along with recordkeeping requirements verifying that reclaimed refrigerant contains no more than 15 percent, by weight, virgin HFCs; and 5) minimizing emissions of HFCs from certain types of fire suppression equipment including the use of recycled HFCs for the service, repair or initial charging of such equipment.

As detailed in the RIA addendum, EPA finds that in some cases specific provisions of the rule would result in compliance costs for industry, while in other cases they may result in cost savings. Provisions that result in a net cost savings may still be considered as part of the economic benefits attributable to this rule, under the assumption that these activities would not otherwise be undertaken at the same scale or rate of adoption in the absence of regulation. More discussion of these assumptions and supporting literature may be found in section 3.2.2 of the Allocation Framework Rule RIA.

From the Agency's analyses, EPA provides the costs and benefits associated with the management of regulated substances and their substitutes under the AIM Act as well those associated with the RCRA alternative standard requirements for hazardous waste. These analyses—as summarized below—highlight economic cost and benefits, including benefits from leak repair and emissions reductions.

Given that the provisions EPA is finalizing concern HFCs, which are subject to the overall phasedown of production and consumption under the AIM Act, EPA relied on its previous estimates of the impacts of already finalized AIM Act rules as a starting point for the assessment of costs and benefits of this rule. Specifically, the Allocation Framework Rule (86 FR 55116, October 5, 2021), the 2024 Allocation Rule (88 FR 46836, July 20, 2023), and the 2023 Technology Transitions Rule (88 FR 73098, October 24, 2023) are assumed as a baseline for this rule. In this way, EPA analyzed the incremental impacts of this rule, attributing benefits only insofar as they are additional to those already assessed in the Allocation Framework Rule RIA, the 2024 Allocation Rule RIA addendum, and the 2023 Technology Transitions Rule RIA addendum (collectively referred to as "Allocation and 2023 Technology Transitions Rules" in this discussion). Climate benefits presented in the RIA addendum are based on changes (increases or reductions) in HFC emissions compared to the 2023 Technology Transitions Rule compliance case[145] (*i.e.*, after consideration of the Allocation Framework Rule, the 2024 Allocation Rule, and the 2023 Technology Transitions Rule.

EPA estimated the climate benefits for this rule using a set of estimates of the social cost of each HFC (SC-HFC, or collectively referred to as SC-HFCs) that is affected by the rule. The SC-HFC is the monetary value of the net harm to society associated with a marginal increase in HFC emissions in a given year, or the net benefit of avoiding that increase. In principle, the SC-HFC includes the value of all climate change impacts (both negative and positive), including (but not limited to) changes in net agricultural productivity, human health effects, property damage from increased flood risk and natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services. The SC-HFC, therefore, reflects the societal value of reducing emissions of the gas in question by one metric ton and is the theoretically appropriate value to use in conducting benefit-cost analyses of policies that affect HFC emissions. In practice, data and modeling limitations restrain the ability of SC-HFC estimates to include all physical, ecological, and economic impacts of climate change, implicitly assigning a value of zero to the omitted climate damages. The estimates are, therefore, a partial accounting of climate change impacts and likely underestimate the marginal benefits of abatement.

The monetization of climate benefits in this analysis uses the same HFC-specific SC-HFC estimates as used in the proposal RIA and in the estimation of the benefits in prior AIM Act

[145] As detailed in the 2023 Technology Transitions RIA addendum, EPA analyzed both a base case and high additionality scenario towards compliance with that rule. The discussion here utilizes the 2023 Technology Transitions high additionality case for comparison purposes to provide a conservative assessment. Further details are provided in the RIA addendum for this rule and the Costs and Benefits TSD.

analyses including the Allocation Framework Rule RIA. That is, for the primary benefits analysis in the final RIA addendum, EPA uses SC-HFC estimates that are consistent with the methodology underlying estimates of the social cost of other GHGs (carbon dioxide [SC-CO_2], methane [SC-CH_4], and nitrous oxide [SC-N_2O]), collectively referred to as SC-GHG, presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under* Executive Order 13990 published in February 2021 by the Interagency Working Group on the Social Cost of Greenhouse Gases (IWG) (IWG 2021). These SC-GHG estimates were recommended for use until updated estimates are available that reflect recent advances in the scientific literature on climate change and its economic impacts and incorporate recommendations made by the National Academies of Science, Engineering, and Medicine (National Academies, 2017). As a member of the IWG involved in the development of the February 2021 SC-GHG TSD, EPA agrees with the explanation in the TSD that it is appropriate for agencies to use the same set of four values drawn from the social cost of greenhouse gases (SC-GHG) distributions based on three discount rates as were used in regulatory analyses between 2010 and 2016 and subject to public comment (2.5 percent, 3 percent, and 5 percent), plus a fourth value, selected as the 95th percentile of estimates based on a 3 percent discount rate. EPA also agrees with the explanation provided in the February 2021 TSD that the use of the social rate of return on capital (7 percent under the 2003 OMB Circular A-4 guidance) to discount the future benefits of reducing GHG emissions inappropriately underestimates the impacts of climate change for the purposes of estimating the social cost of GHGs. For purposes of capturing uncertainty around the SC-HFC estimates applied in this analysis, we emphasize the importance of all four values for each HFC affected by the rule.

In addition, in an Appendix to the final RIA addendum, EPA presents the monetized climate benefits of the final rule using a new set of SC-HFC estimates that reflects recent advances in the scientific literature and addresses the National Academies' updating recommendations. The methodology underlying these updated SC-HFC estimates is consistent with the SC-GHG estimates used in the EPA's 2023 RIA for the Final Oil and Gas New Source Performance Standards (NSPS)/Emissions Guidelines (EG) Rulemaking, "Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review". Specifically, the draft updated methodology incorporates new literature and research consistent with the National Academies near-term recommendations on socioeconomic and emissions inputs, climate modeling components, discounting approaches, and treatment of uncertainty, and an enhanced representation of how physical impacts of climate change translate to economic damages in the modeling framework based on the best and readily adaptable damage functions available in the peer reviewed literature. As EPA noted in the proposal for this rule, EPA presented and solicited public comment on this updated methodology within a sensitivity analysis in the regulatory impact analysis of EPA's November 2022 supplemental proposal for oil and natural gas emissions standards.[146] EPA also conducted an external peer review of the accompanying technical report that explains the methodology underling the new set of estimates. Complete information about the public comments and external peer review, including the peer reviewer selection process, the final report with individual recommendations from peer reviewers, and the

[146] Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review (87 FR 74702, December 6, 2022).

EPA's response to both public comments and peer reviewer recommendations is available on EPA's website,[147] as well as in the RIA for this rule.

B. Estimated costs and benefits of the final rule

1. Total incremental costs and benefits of the final rule

As discussed above, the HFC Allocation and 2023 Technology Transitions Rules serve as the status quo from which incremental impacts of this final rule are evaluated. As detailed in the RIA and subsequent RIA addenda for these previous rules, EPA modeled multiple potential compliance pathways to meeting the requirements of these rulemakings. In one scenario, EPA assumed that industry would comply with previous AIM Act regulations as outlined in the 2023 Technology Transitions RIA Addendum[148] without undertaking some improvements to leak repair and refrigerant recovery practices in response to these previous rulemakings and as a means of achieving the overall HFC phasedown cap. Because these improvements are not required to meet previous AIM Act regulations, in our base case scenario for the estimated incremental impacts of the ER&R rule, EPA has also included them in the baseline. in. However, since whether industry undertakes such improvements is ultimately uncertain, EPA has also provided an alternative scenario in the RIA addendum where some improved leak repair and refrigerant recovery practices are included in the baseline, thus illustrating a potential lower bound of incremental impacts.

The present value of the net benefits of the final ER&R rule are equal to the sum of the net costs or benefits of the various provisions in each year from 2026 through 2050, discounted

[147] https://www.epa.gov/environmental-economics/scghg

[148] In the 2023 Technology Transitions RIA Addendum, we analyzed a "base case" and a "high additionality" scenario. The former is used to analyze the base case scenario for this rule. See the RIA Addendum and the Economic Impact and Benefits TSD for additional details.

to 2024 (the year in which this rule is being finalized). In our base case, EPA estimates the provisions of this rule will result in cumulative incremental emissions reductions of approximately 120 $MMTCO_2e$ from 2026 through 2050, and the present value of economic benefit of avoiding the damages associated with those emissions is estimated at $8.4 billion (discounted to 2024 using a three percent discount rate).[149] EPA estimates the present value of compliance costs associated with this rulemaking to be $1.5 billion at a two percent discount rate, $1.3 billion at a three percent discount rate, or $0.9billion at a seven percent discount rate. When including the economic benefit of avoided climate damages, the net benefit of the rule is therefore estimated to range from $6.9 billion (two percent discount rate for compliance costs) to $7.5 billion (seven percent discount rate for compliance costs). These estimates are summarized in table 8 below along with annual, undiscounted values for select years.

Table 8: *Summary of Undiscounted Annual Values, Present Values, and Equivalent Annualized Values select years for the 2026 through 2050 Timeframe for Estimated Compliance Costs, Benefits, and Net Benefits for the ER&R Rule (millions of 2022$, discounted to 2024) – Base Case Scenario* [a,b,c,d]

Year	*Climate Benefits*	*Costs*			*Net Benefits*		
2026	$428	$92			$336		
2030	$676	$102			$574		
2035	$613	$86			$526		
2040	$466	$67			$399		
2045	$315	$51			$264		
2050	$263	$52			$211		
Discount rate	3%	2%	3%	7%	2%	3%	7%
Present value	$8,356	$1,499	$1,335	$884	$6,857	$7,021	$7,471
Equivalent annualized value (EAV)	$480	$77	$77	$76	$403	$403	$404

[a] Benefits include only those related to climate. Climate benefits are based on changes (reductions) in HFC emissions and are calculated using four different estimates of the social cost of HFCs (SC-HFCs): model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate. For the presentational

[149] Unless stated otherwise, costs and benefits in this section are presented in 2022 dollars.

purposes of this table, we show the benefits associated with the average SC-HFC at a 3 percent discount rate. More details can be found in the final rule RIA addendum.
[b] Rows may not appear to add correctly due to rounding.
[c] The annualized present value of costs and benefits are calculated as if they occur over a 25-year period.
[d] The present value (PV) for the net benefits column is found by taking the difference between the PV of climate benefits at 3 percent and the PV of costs discounted at 7 percent, 3 percent or 2 percent. Because the SC-HFC estimates reflect net climate change damages in terms of reduced consumption (or monetary consumption equivalents), the use of the social rate of return on capital (7 percent under OMB Circular A-4 (2003)) to discount damages estimated in terms of reduced consumption would inappropriately underestimate the impacts of climate change for the purposes of estimating the SC-HFC.

The provisions which contribute to the total net benefits of the final rule are those covering leak inspections, leak repair, installation of ALD systems, reduced emissions and use of recycled HFCs in the fire suppression sector, management and ultimate evacuation of disposable cylinders, and the required use of reclaimed HFCs for the servicing and/or repair of certain refrigerant-containing equipment, and all associated recordkeeping and reporting requirements. Estimated costs, benefits, and resulting net benefits are provided by type of provision in table 9 below.

Table 9: *Summary of Present Value Costs, Benefits, and Net Benefits by Rule Provision (millions of 2022$, discounted to 2024) – Base Case Scenario*

Provision	Climate Benefits (3%)	Costs (Savings) (2%)	Costs (Savings) (3%)	Costs (Savings) (7%)	Net Benefits 3% Benefits, 2% Costs)	Net Benefits (3% Benefits, 3% Costs)	Net Benefits (3% Benefits, 7% Costs)
Leak Repair And ALD	$6,176	$1,285	$1,146	$760	$4,891	$5,031	$5,417
Fire Suppression	$14	$15	$13	$7	($1)	$1	$7
Cylinder Management	$2,165	($195)	($169)	($101)	$2,360	$2,335	$2,266
Use of Reclaim (servicing)		$43	$38	$23	($43)	($38)	($23)
Recordkeeping & Reporting		$350	$308	$195	($350)	($308)	($195)
RCRA Alternative Standard Requirements**	-	$0 to ($40)	$0 to ($35)	$0 to ($22)	$0 to ($40)	$0 to ($35)	$0 to ($22)

*As detailed in the RIA addendum, reclaim requirements may lead to additional emissions reductions by inducing increased recovery of refrigerant at servicing and disposal that may otherwise be released or vented. In our base case scenario, EPA does not estimate an increase in these avoided emissions beyond baseline assumptions. See the RIA addendum for additional analysis related to this assumption.

** RCRA alternative standard requirements are not included in the total benefits of this final rule as presented in the text above but are included here for informational purposes.

2. Estimating costs and benefits based on affected equipment and appliances

As detailed in the RIA addendum, the number, charge sizes, leak rates, and other characteristics of affected RACHP and fire suppression equipment, and the benefits realized through the requirements of this rulemaking, were estimated using EPA's Vintaging Model.[150] For example, for RACHP equipment covered by the rule's leak repair and ALD system provisions, the requirements are assumed to lead to leaking systems being repaired earlier than they otherwise would have, leading to reduced emissions of HFCs. The reduction in HFC emissions results in climate benefits due to reduced climate forcing as calculated by multiplying avoided emissions by the social cost of each SC-HFC.

In the years 2026 through 2050, the final rule's leak repair and ALD system provisions in particular would prevent an estimated 88.5 MMTCO$_2$e in HFC emissions, and the present value of the economic benefit of avoiding the damages associated with those emissions is estimated at $6.2 billion (in 2022 dollars, discounted to 2024 using a 3 percent discount rate). These benefits, as well as those resulting from other provisions contained in the ER&R final rule, are estimated to decrease over time due to the HFC phasedown and the transition out of the higher-GWP HFCs, lowering the average GWP of avoided future emissions. For example, it is estimated that the leak repair and ALD system provisions would prevent approximately 5.6 MMTCO$_2$e of HFC emissions in 2030, which decreases to approximately 3 MMTCO$_2$e of HFC emissions in 2040.

[150] EPA. 2024. EPA's Vintaging Model representing the Allocation Framework Rule as modified by the 2024 Allocation Rule RIA addendum. VM IO file_v4.4_02.04.16_Final TT Rule 2023 High Addition.xls.

Some provisions contained in the final rule are also estimated to yield cost savings. For example, reducing HFC emissions due to fixing leaks earlier would also be anticipated to lead to savings for system owner/operators, as less new refrigerant would need to be purchased to replace leaked refrigerant. In 2026, it is estimated that the proposed leak repair and ALD system provisions would lead to savings of approximately $19.5 million (2022$).

The compliance costs of the leak repair and inspection requirements in particular include the costs of purchasing and operating ALD systems, costs of required inspections, and the cost of repairing leaks earlier than would have been necessary without the provisions. In the years 2026 through 2050, these provisions, when combined with the refrigerant savings, would result in net compliance costs with a present value estimated at $1.15 billion (2022 dollars, discounted to 2024 at a 3 percent discount rate). More details on underlying assumptions for these estimates can be found in the RIA addendum for the final rule and its accompanying appendices.

Comment: One commenter stated that the regulations put in place by EPA will provide health benefits to technicians and their consumers. The commenter also stated that there will be environmental benefits since the HFC Phasedown Program encourages recycling HFCs to reduce GHG production rates.

The commenter also noted that for this transition, states are providing incentive programs to help companies adjust to the new standards proposed by EPA. The commenter mentioned that California and Delaware have programs to increase the use of low-GWP refrigerants. The commenter stated that this is a great way to show support for the proposed rule because it is evident that businesses will lose a significant portion of funding with the transition to eco-friendly refrigerants.

The commenter further stated that they wished the proposed rule had more data on the environmental and health impacts of not switching to friendlier HFCs instead of "briefly" discussing it.

Response: EPA acknowledges the commenter's support for this rule. EPA's modeling for this rule focused on how the rule would impact GHG emissions and the HFC marketplace. We acknowledge the comments on the environmental benefits of the HFC Phasedown Program and moreover the global HFC phasedown under the Montreal Protocol's Kigali Amendment but note that this is outside the scope for this rulemaking, as EPA did not propose to revise regulations to phase down HFCs in this rulemaking. In response to comments on state HFC-management programs, EPA acknowledges the presence of state-level HFC management programs and has referenced some of those programs at various points in this rulemaking, for informational purposes and additional context. For example, EPA cited CARB's refrigerant management program when discussing charge-size thresholds for ALD systems in IV.D.1. EPA further notes that requirements and incentives of such state programs are also outside the scope of this rulemaking, as those are developed and implemented by state regulators rather than EPA.

Comment: One commenter stated that the costs in EPA's cost/benefit analysis for entering records is grossly underestimated, and a more accurate estimate would be 10 minutes. The commenter noted that the 10-minute estimate includes the assumption that the service contractor is recording entries correctly the first time and the record-keeping software loads immediately. The commenter additionally stated that due to the number of small appliances that will be added to the recordkeeping burden, recordkeeping burden will increase between 50 to 100 percent.

Response: EPA notes that the commenter is not specific in regards to which particular record entry cost assumption they claim is an underestimate. EPA has included estimated recordkeeping and reporting costs as a part of total estimated compliance costs in the RIA addendum. These estimates include cost burden assumptions derived from the ICR (EPA ICR Number 2778.01, https://www.regulations.gov/document/EPA-HQ-OAR-2022-0606-0025), which estimated labor hours ranging from minutes to up to 40 hours per requirement, depending on the specific recordkeeping or reporting requirement. EPA has not received specific data or information indicating that any of these assumptions need to be revised upward in any particular case, and the comment does not provide any information or data to support the assertion that 10 minutes would be a more accurate assumption for the estimate they disagree with. In regards to the recordkeeping burden for small appliances, EPA acknowledges that the inclusion of refrigerant-containing appliances with charge sizes of 15 pounds or more in this rulemaking's leak repair provisions may increase recordkeeping burden compared to the recordkeeping burden if the ER&R regulations were to only cover equipment with charge sizes of 50 pounds or more. EPA's rationale for the 15 pound charge size is described elsewhere in this preamble.

Comment: Another commenter expressed concern that if finalized in its current form, the proposed rule would place significant and disproportionate burdens on the grocery industry and other retailers, and that new compliance and administrative burdens created by the proposed rule would lead to increased costs of doing business, which would ultimately be passed on to consumers. The commenter stated that the proposed new requirements would have significant costs that are not accounted for in the Analysis of Economic Impact and Benefits TSD or in the RIA addendum to the Allocation Framework Rule RIA. The commenter noted several drivers of compliance costs:

- Tight compliance timeframes that will necessitate allocation of personnel and financial resources.
- Increased demand for and limited supply of reclaimed and/or recycled HFCs.
- Increased demand for and limited supply of ALD systems.
- The installation, training, and maintenance costs associated with ALD installation.
- The need to re-train technicians and maintenance personnel.
- Required retrofit or retirement of appliances with leaks that cannot be repaired in accordance with the proposed repair standard.

The commenter further stated that the Technology Transitions regulatory program will place a significant strain on supply chains and technicians, driving up costs, and that EPA's proposal to impose additional sweeping, mandatory system repair requirements in the near future will further drive a surge in demand for technicians, equipment, and refrigerants. The commenter added that the proposed new requirements, and their varying compliance timeframes, applicability thresholds, recordkeeping, and reporting requirements, will introduce administrative complexity, and that this additional burden is particularly pronounced for the commenter's members who are managing compliance for different sites in multiple states, each of which are equipped with different types of regulated appliances.

The commenter further argued that the requirements in the proposed rule were unnecessary and would add significant regulatory burdens for little practical gain. The commenter suggested that as the phasedown will create a limited supply of HFCs in future years, businesses will already be well-incentivized to conduct repairs, minimize leaks, and use reclaimed HFCs, meaning that the regulatory mandates proposed are unnecessary. The commenter argued that the costs and administrative burdens associated with the proposed rule are not justified for equipment that will be obsolete by the end of the HFC phasedown mandated in the AIM Act.

Response: In response, EPA notes that Congress directed the Agency in subsection (h)(1) of the AIM Act to promulgate certain regulations, and that the authority conveyed under subsection (h) is separate from, and in addition to, authority Congress conveyed under other provisions of the Act. EPA is establishing the ER&R program to implement subsection (h), consistent with Congress's direction. EPA further notes, as discussed in greater detail elsewhere in this preamble, this rulemaking is designed to serve the purposes identified in subsection (h)(1) of the AIM Act of maximizing reclamation, minimizing the release of regulated substances from equipment, and ensuring the safety of technicians and consumers. EPA did not propose and is not making any changes to the 2023 Technology Transitions Rule; comments with respect to the costs of that rule are out of scope for this rule and require no further response. However, we note that the analysis of the costs of the ER&R Rule incorporated the effects of the 2023 Technology Transitions Rule as the baseline from which incremental costs and benefits were estimated.

While EPA has included estimates of the costs and benefits of this rulemaking in the RIA addendum (and reevaluated the costs and benefits of the final rule under two principal scenarios and provided sensitivity analyses around these estimates), to provide the public with information on the relevant costs and benefits of this action and to comply with Executive Orders, that analysis does not form a basis or rationale for any of the provisions promulgated in this rulemaking. To the extent that EPA has considered the results of analyses of the impacts of the provisions of the ER&R program in this rulemaking, those results are reflected in the Economic Impact and Benefits TSD. Further, while certain provisions of the AIM Act do expressly mention the consideration of certain costs, such as subsections (i)(4)(B) and (i)(4)(C), in this rulemaking, the Agency is not addressing those provisions nor are we reopening regulations already promulgated under that separate authority. Nothing in the AIM Act requires EPA to consider costs or identifies any particular cost-based metric or analytical approach for use in evaluating and establishing regulations to implement subsection (h). Subsection (h)(1) does, however, identify particular purposes that the regulations promulgated under that subsection are to serve, and EPA has focused on serving those purposes in adopting the requirements in this rulemaking. EPA further responds that many of the potential drivers of compliance costs cited by the commenter are uncertain; however, EPA has nonetheless endeavored to include such drivers in its assessment of compliance costs to the extent practicable and based on best available data as detailed in the Economic Impact and Benefits TSD. For example, regarding costs associated with ALD systems, as noted in the RIA addendum, EPA has included the capital expenditure to purchase the hardware (*e.g.*, detector, sensors), plus installation costs and operations and maintenance (O&M) costs associated with annual system maintenance, certification, and data tracking/storage. EPA has also included potential costs associated with retrofit or retirement of equipment with leaks that cannot be repaired, as detailed in the RIA addendum and Economic Impact and Benefits TSD. Finally, regarding the need to re-train technicians and personnel, EPA has included labor costs associated with ALD, leak inspection and repair, cylinder management, and fire suppression activities required by this rule. EPA acknowledges that regular training and re-certification is an integral part of the job requirements of affected technicians and personnel. The comments did not provide, and EPA is not aware of, data indicating that training requirements contained in this rule would translate into higher labor hour or labor rate assumptions beyond those already included in the analysis contained in the RIA addendum and Economic Impact and Benefits TSD.

Regarding compliance timeframes, EPA notes that for many of the provisions contained in the final rule they have been extended relative to those contained in the proposed rulemaking, thus partially mitigating potential cost increases related to compliance deadlines and allowing additional time for technician and other personnel training as needed, as well as other steps that are necessary for compliance.

Regarding supply of reclaimed HFCs, EPA has provided data based on results from its Vintaging Model in both the proposed and final rule RIA addendum on the amount of reclaimed refrigerant that would be required to meet the requirements of the rule. EPA notes that this amount is significantly lower in the final rule, as the use of reclaim requirements of the final rule only cover a subset of the end-use categories. EPA has not seen data provided in comments indicating that there would be a shortfall in supply of reclaimed refrigerant, nor does EPA anticipate such a shortfall based on estimated supply and demand of refrigerant using the Vintaging Model. For more information regarding supply of reclaimed HFCs, see responses to comments elsewhere in this preamble in section IV.E.1 and IV.E.2.

Regarding supply of ALD systems, see responses to comments elsewhere in this preamble in sections section IV.D.

Although the 2023 Technology Transitions rule is not addressed or reopened in this final rule, as the commenter notes, provisions of that rule may lead to retailers in the future using alternatives that would not be subject to the provision of this rule. (*e.g.*, alternatives that do not include a regulated substance or otherwise has a GWP equal to or below 53). Based on its analysis, EPA finds that the 2023 Technology Transitions Rule has the effect of reducing estimated compliance costs associated with the final ER&R rule. This is because industry transitions away from higher-GWP HFCs in response to the 2023 Technology Transitions Rule are expected to reduce the overall amount of equipment affected by the final ER&R Rule requirements (i.e., appliances which use an HFC or substitute for an HFC with a GWP greater than 53). However, EPA disagrees with the commenter's assertion that the requirements are unnecessary and notes that it explains the justification for the requirements in this rule in the sections of the preamble discussing the respective requirements, as well as in the relevant sections of the proposal. EPA also disagrees with the commenters' assertions that the requirements will result in little practical gain. EPA's analysis describing the benefits of these requirements can be found in the RIA addendum and the TSD for this rule.

EPA also disagrees with the commenter's assertions that equipment covered under this rule's provisions will become obsolete due to the HFC phasedown under the AIM Act, and that the rule's provisions are therefore adding unnecessary regulatory burden without providing additional benefits. Provisions promulgated in this rulemaking have compliance dates beginning between 2026-2030, and cover a broad range of new and existing equipment that will be using regulated substances or substitutes for a regulated substance with GWPs greater than 53 after the last phasedown step is scheduled to occur in 2036. While these compliance dates overlap with the compliance timelines established for new equipment under the 2023 Technology Transitions Rule, some new refrigerant-containing equipment purchased after the applicable compliance date for the sector or subsector in the 2023Technology Transitions Rule will still use regulated substances or substitutes with GWPs greater than 53 and thus will be subject to the regulations established under the ER&R program. Additionally, existing equipment that is not subject to requirements under the 2023 Technology Transitions rule will still be subject to the ER&R

program's provisions until the end of its useful life. Thus, by promulgating regulations intended to maximize reclamation and minimize release of HFCs from equipment in this rulemaking, EPA is addressing equipment and practices, practices and activities that are not specifically addressed under other AIM Act programs.

Comment: Two commenters opposed EPA's use of climate benefits in the analysis. The commenters argued that the purpose of the AIM Act is to promote American manufacturing, not to regulate GHGs, and stated that the statute itself never mentions GHGs or climate change, which the commenters argued was for good reason, since according to the commenters the divisiveness of climate change policy prevented Congress and the Executive from reaching consensus on any policy explicitly directed at climate change. Instead, the commenters argued that the law (as evident in the title '"Innovation and Manufacturing'") focused on the economic benefits to certain U.S. chemical manufacturers, including fostering innovation in the chemicals industry. The commenters further pointed to EPA's statement that the social cost of carbon is not a record basis for the Agency action, which they alleged to be an acknowledgement that EPA cannot legally take climate benefits into account. One of the commenters argued that EPA expressly disclaims any reliance on the "High Additionality" scenario as the legal basis of the proposed rule.

This commenter further argued that there is zero benefit from mandating the use of reclaim gas in various RACHP subsectors, citing Table 8 of the proposed rule, and that EPA glosses over the lack of any benefit in its cost-benefit analysis for the reclaim provisions. The commenter further claimed that contrary to its duty to use reasoned decision making, EPA fails to engage in any substantive discussion of why an agency would adopt a rule (such as the reclaim mandate) that has no benefits that the government can legally promote. The commenter argued that the AIM Act is not a climate law, that climate change is not part of the AIM Act, and that climate change cannot be considered as a justification for implementing regulations under the statute. The commenter concluded that EPA has failed to explain why a regulation with no economic or environmental benefit should be added to the regulatory burden on the refrigerant sector, and that the rule is arbitrary and capricious.

The other commenter stated that EPA's cost-benefit analysis improperly considers assumed climate benefits and foreign benefits while failing to consider overwhelming cost-benefit imbalances to U.S. manufacturers, and that adequate data was not gathered from impacted industries. The commenter argued that climate benefits were not Congress' goal, that climate change is not part of the AIM Act and may not be considered as a justification for implementing regulations under the statute, and that given the statutes [sic] sole focus on American manufacturing, EPA's use of cost-benefit analysis of climate change benefits to justify the refrigerant management requirements is based on improper considerations. Accordingly, the commenter stated EPA should remove the discussion of climate benefits from the rulemaking record and rely solely on the core cost-benefit considerations, which they argued overwhelmingly militate against the proposed rulemaking. The commenter stated that the rulemaking proposal makes clear that the costly burden on refrigeration users would not be justified, except if EPA uses the asserted benefits of climate change as a justification for the rule. The commenter further claimed that EPA may not use supposed climate benefits for foreign countries or residents of foreign countries as a basis for regulation of domestic industries, citing *E.E.O.C. v. Arabian Am. Oil Co.*, 499 U.S. 244, 254 (1991).

The commenter further argued that EPA's cost-benefit analysis is incomplete, and that since the purpose of the AIM Act, and therefor EPA's rulemaking, is focused solely on

American innovation and manufacturing, EPA must assess the costs and benefits of the proposed HFC management rule in relation to the proposed rule's potential impact on the U.S. manufacturing sector. The commenter argued that this analysis should include an assessment of how certain chemical producers of HFC substitutes are benefiting from the AIM Act in general and the management rule in particular, and that EPA's analysis should disclose how the chemical industry that produces substitute chemicals as replacements for HFCs currently used in IPR and other refrigeration equipment might benefit as a result of the government's intervention into the refrigerant sector through product bans. A third commenter stated that the value proposition of implementing the proposed rule is significant but suggested that a further analysis of the $3.7 billion that EPA estimated in total costs is needed.

Response: EPA responds that for the reasons explained in greater detail in the prior response and elsewhere in this rulemaking, while EPA has included estimates of the costs and benefits of this rulemaking in the RIA addendum (and reevaluated the costs and benefits of the final rule under two principal scenarios and provided sensitivity analyses around these estimates), to provide the public with information on the relevant costs and benefits of this action and to comply with Executive Orders, that analysis does not form a basis or rationale for any of the provisions EPA is promulgating in this rulemaking. The Agency did not rely on the "High Additionality" scenario performed for the proposed rule, just as it did not rely on *any* other scenario so performed, as a basis or rationale for this rulemaking. Likewise, we are not relying on any scenario performed for the final rule to justify the regulations finalized in this rule. To the extent these comments assume that this rule is based on the monetized climate benefits reflected in the RIA addendum, they are based on a mistaken premise. As explained in the proposal and in section I.C of this preamble, while EPA included estimated climate benefits in the RIA addendum that were calculated using SC-HFCs, EPA did not rely on those estimates of these monetized climate benefits of the estimated HFC emissions reductions as a record basis for the Agency's action and would reach the conclusions in this rule even in the absence of the SC-HFCs. In clarifying the role of these analyses in the decision making for this rule, EPA is not taking any position on what SC-HFC benefits it could or could not take into account as a legal matter, but rather is simply describing, as a factual matter, its approach in this rule. In addition, as explained throughout this preamble, this rulemaking is designed to serve the purposes identified in subsection (h)(1) of the AIM Act of maximizing reclamation and minimizing the release of regulated substances and ensuring the safety of technicians and consumers. To the extent that these comments are intended to suggest that EPA cannot consider effects on GHG emissions in promulgating regulations under subsection (h), that position is at odds with the plain text of the Act. For example, as explained previously, HFCs are potent GHGs and subsection (h)(1) directs EPA to establish certain regulations for purposes which include minimizing releases of HFCs from equipment.[151] Thus, subsection (h)(1) on its face authorizes EPA to regulate certain GHGs and to focus on minimizing certain sources of emissions of those GHGs, indicating that Congress intended for EPA to address these GHG emissions under subsection (h).

With respect to the commenter's assertion that EPA may not rely on climate benefits for foreign countries or residents of foreign countries as a basis for regulating domestic industries, EPA responds that it is not clear what relevance this assertion has to this rulemaking. As noted previously, EPA is not relying on the quantification of climate benefits in the RIA addendum as

[151] The comments emphasize the appearance of the terms "innovation" and "manufacturing" in the title of the AIM Act, but "headings and titles are not meant to take the place of the detailed provisions of the text." *Bhd. of R.R. Trainmen v. Balt. & O.R. Co.*, 331 U.S. 519, 528 (1947).

a record basis for this rulemaking. Further, while the commenter cites *E.E.O.C. v. Arabian Am. Oil Co*., 499 U.S. 244, 254 (1991), it is unclear to EPA what bearing that decision, which addresses whether Title VII of the Civil Rights Act of 1964 applies extraterritorially to regulate the employment practices of United States employers who employ United States citizens abroad, has on this issue, and the commenters have offered no further explanation. To the extent the commenter was indicating that EPA may not use the global SC-HFC estimates in the RIA addendum, EPA addressed accounting for global damages in EPA's "Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances" (Nov. 2023).[152] For additional discussion on this issue, EPA would also refer the commenter to Appendix A of the response to public comments document available in the docket for "Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review."[153] With respect to the commenter's position that there are "zero benefits" from reclaim, we disagree. In the RIA addendum and Economic Impact and Benefits TSD, while we conservatively do not attribute emission reductions from such provisions, we do estimate a reduction in consumption of HFCs. Regardless, the purpose of these provision is not to provide a specific benefit; rather, as already explained, the purpose is to fulfill in a reasonable manner the statutory requirements of maximizing reclamation.

We further note that the existence of some publicly available information which may be of interest to these commenters. Information on the production and consumption of HFCs is provided on EPA's HFC Data Hub.[154] While information on chemical producers' "benefits" are

[152] Available at: *https://www.epa.gov/system/files/documents/2023-12/epa_scghg_2023_report_final.pdf*
[153] Available at: *https://www.regulations.gov/document/EPA-HQ-OAR-2021-0317-4009*
[154] Available at: *https://www.epa.gov/climate-hfcs-reduction/hfc-data-hub*

not reportable under AIM Act regulations, we invite the commenter to refer to company reports including filings with the U.S. Securities and Exchange Commission. For the manufacturing sector, EPA would also direct the commenters to a 2018 industry-commissioned study titled *Economic Ratification of the Kigali Amendment*,[155] which found significant economic benefits in terms of increased manufacturing output and job creation.

Comment: One commenter stated that they did not carefully reproduce the estimated savings and benefits as would have been done if there had been more time for comments, but responded to the assumption that the estimated savings "would not be expected to decrease over time, as the cost of refrigerant would not decrease with the average GWP," suggesting that it is possible that the cost of refrigerant will decrease over time as it has in the past and as there is more extensive use of non-fluorinated alternatives.

Response: EPA agrees that the cost of refrigerants may decrease over time, but also notes it may increase over time as HFCs are phased down. In light of this uncertainty and for consistency and comparability with prior analyses, in the RIA addendum and Economic Impact and Benefits TSD EPA has applied a constant cost of new refrigerant (of $4 per pound) equal to that used in previous analyses under the AIM Act. EPA further notes that a slightly higher cost (of $4.40 per pound) was applied for reclaimed refrigerant. More details on these assumptions and resulting estimated costs and benefits, and a sensitivity study of the cost of reclaimed refrigerant, can be found in the RIA addendum and Economic Impacts and Benefits TSD, which are available in the docket for this rule.

[155] Inforum and JMS Consulting, 2018. Economic Impacts of U.S. Ratification of the Kigali Amendment. Available at: *https://www.alliancepolicy.org/site/usermedia/application/6/Kigali_Economic_Report.pdf*

Comment: One commenter stated that they are a champion of LRM, a climate change mitigation strategy aimed at detecting and repairing refrigerant leaks; recovering, reclaiming, and destroying refrigerant; and designing and installing equipment with high energy efficiency and lower-GWP refrigerants. The commenter shared that LRM can have a profound climate impact, with the potential to mitigate 91 gigatons CO_2e globally by 2100, with a tenth of those emissions reductions happening in the United States.

Response: EPA acknowledges the commenter's perspective. The Agency notes that several of the strategies mentioned by the commenter are similar to requirements being finalized in this rule. While outside the scope of this rulemaking, EPA also notes that the Agency has restricted the use of higher GWP substances in multiple RACHP, Foams, and Aerosol subsectors in the 2023 Technology Transitions rule (88 FR 73098, October 24, 2023).

Comment: One commenter requested that EPA confirm the impacts of the technology transitions mandates were considered in the proposed rule, and if they were not considered, the commenter requests that EPA reconsider the impacts of technology transitions in a supplemental rulemaking.

Response: EPA responds that the 2023 Technology Transitions rule was not final at the time of the proposed rulemaking and thus was not included in the baseline for the cost and benefits analysis completed for the proposal. However, given the 2023 Technology Transitions rule has since been finalized, the impacts of that rule are assumed in the baseline for the costs and benefits analysis conducted for this final rule. These assumptions are detailed in the RIA addendum that are in the docket for this rulemaking.

Comment: Several commenters in broad support of the proposal, stated that the rule's requirements enhance LRM and implement activities and practices which assist in preventing leaks and encouraging the recovery and reclamation of HFCs. The commenters highlighted their joint report "The 90 Billion Ton Opportunity: Lifecycle Refrigerant Management." One of the commenter's stated that minimizing leaks from appliances and ensuring the recovery, reclamation, and destruction of refrigerants at EOL could avoid the emissions of 9.2 billion $MTCO_2e$ by 2100 in the United States alone. The commenter stated the widespread adoption of LRM globally could avoid emissions up to 91 billion $MTCO_2e$ by 2100.

Response: EPA acknowledges the commenters' broad support for the rule. As described elsewhere in this preamble, this rule is designed to serve the purposes identified in subsection (h)(1) of the AIM Act, including minimizing releases of HFC from equipment and maximizing reclamation.

Comment: One commenter stated that owners and operators of systems of all sizes will incur economic benefits from promptly repairing leaks. The commenter stated that better maintenance of systems through leak repair will save owners and operators money by reducing the amount of HFC needed to service existing systems and ensure the viability of refrigerated products.

Response: EPA agrees with this statement.

Comment: Another commenter expressed support for EPA's proposed leak detection and repair requirements. The commenter noted that these proposed requirements will have positive benefits for the atmosphere and climate and will help ease demand for servicing gas.

Response: EPA agrees with these statements.

Comment: One commenter in support of the leak repair and ALD provisions in the proposal stated that many New York businesses would experience savings upwards of $13 million by 2025 by lowering overall refrigerant and energy costs.

Response: EPA acknowledges the commenter's support for the leak repair and ALD requirements and agrees that refrigerant management will lead to savings on refrigerant and energy costs.

Comment: One commenter argued that lowering the charge threshold to five pounds will yield significant additional avoided GHG emissions. The commenter mentioned that most of the additional reductions are estimated to come from road transport refrigeration units, which under the Technology Transitions rule are not yet required to transition to low-GWP refrigerant alternatives and have high estimated annual leak rates. The commenter noted that road transport refrigeration units merit being subject to additional leak management requirements. Another commenter similarly stated that lowering the charge size threshold would provide additional emissions benefits from the road transport sector. The commenter further stated that a five-pound threshold would avoid emissions totaling 86 $MMTCO_2e$ by 2050 with annual refrigerant savings of $1,080,000.

Response: EPA explains the Agency's decision to set a leak repair charge size threshold of 15 pounds rather than 5 pounds in section IV.C.2 in this final rule. EPA provided estimates of using various charge size thresholds in the RIA addendum and Economic Impact and Benefits TSD associated with the proposed rule for informational purposes and to comply with Executive Orders. We also note that in these documents as updated for this final rule we assess the impacts of road transportation refrigeration units using reclaimed refrigerant for servicing or repair.

Comment: Three commenters expressed concern that lowering the applicability threshold for the leak repair requirements would significantly increase costs for sources. One of the commenters mentioned that even EPA's analysis indicated that lowering the threshold to 15 pounds, or even 30 pounds, would not be cost-effective. Another commenter stated that with the

15-pound threshold that EPA proposed, the number of covered appliances for one of its' members' enterprises would increase more than ten-fold (from 600 to 6,100 individual units). The commenter claimed that such a dramatic increase in the number of covered appliances could result in approximately $1 billion in additional capital costs to the company over the next 10 years. The commenter further stated that another member estimates that conducting site surveys of all of its stores to identify newly-covered appliances under the "15-pound threshold" would cost roughly $500 to $1,000 per site, depending on location and size. When multiplied across many sites, this would lead to significant costs just to identify newly covered equipment. The commenter stated that as a practical matter, regulating small, packaged units, VRF systems, and mini-splits would greatly increase the recordkeeping burden on owners and operators under the regulations, and would increase costs for inspections and carrying out retrofit and/or retirement plans. The commenter stated that many HVAC appliances contain multiple circuits within a unit, each with its own recordkeeping obligations and leak rates. This increases compliance costs and makes it more difficult to fix, repair, and/or retrofit appliances.

EPA also received another comment similarly arguing that rule would impose a financial burden to food retailers due to the increased number of affected appliances. Specifically, the commenter estimates that audits of stores to determine which appliances would be subject to the leak repair requirements would be between $1,000 and $2,000 dollars per supermarket and upwards of $700 dollars for convenience stores further estimating a total cost of $258,872,850 to the food retail industry. The commenter also expressed concern that many smaller appliances would need to be added to a company's recordkeeping, because appliances not previously covered under section 608 would not have had their full charge data captured. The commenter estimates the costs of reweighing smaller refrigerant-containing appliances to determine full charge will cost individual stores a minimum of $1,287 which industry-wide would result in an additional $81,534,800 in compliance costs.

Response: As discussed in section IV.C.2, EPA is finalizing the 15-pound charge size threshold as proposed for the leak repair requirements. In the RIA addendum and Economic Impact and Benefits TSD for the proposed rulemaking, the Agency assessed the costs and benefits of choosing a different threshold or informational purposes and to comply with Executive Orders. Regarding one commenter's assertion that the rule would institute additional recordkeeping and compliance costs for certain HVAC appliances, the Agency refers the commenter to further discussions on the exemption of refrigerant-containing appliances used in the residential and light commercial air conditioning and heat pumps subsector in section IV.C.2. EPA notes that several of the refrigerant containing appliances the commenter describes (*e.g.*, mini-splits) may be considered to be a part of the residential and light commercial air conditioning and heat pumps sector and thus are exempt from the leak repair requirements in this final rule. EPA disagrees with the commenters' assessments of capital costs associated with complying with the leak repair provision and with the comments related to site surveys and store audits. Owners and operators would need to review and inventory of equipment and assess which equipment is subject to the rule's leak repair requirements regardless of where the threshold is set. Supermarkets and other entities should be able to ascertain which appliances are at or above the 15-pound threshold. Furthermore, owners or operators most likely have records of refrigerant-containing appliances that would allow them to determine if the full charge was at or above the 15-pound threshold. For instance, owner's manuals might provide the OEM's assessment of the full charge, or service records from when the equipment was installed and first filled or checked might provide the necessary information. The Agency understands that most stand-alone units would be below 15 pounds but to the extent that certain stand-alone units are above the 15-pound threshold owners or operators should be able to easily determine the charge size and type of refrigerant being used via a manufacturer label. Further, if an owner or operator is using the same make and model of refrigerant-containing appliance then they would not need to verify each individual appliance. Remote condensing units (e.g., supermarket cold rooms) may also have charge sizes at or above 15 pounds but as previously stated, previous records, manufacturer labels, and other information readily available should make the determination of the charge size for any such appliances uncomplicated. Similarly, the associated costs of recordkeeping for owners and operators will be more or less the same as it was under the CAA section 608 regulations, given the similarities of the recordkeeping requirements between the two programs. EPA does not anticipate that it would typically be necessary to conduct full store audits of appliances or reweigh appliances in the way the commenters suggest for these reasons. Thus, EPA disagrees with the asserted cost estimates for determining which appliances are subject to leak repair under the final rule. The Agency further notes that the commenters did not provide adequate information to persuasively explain why such high costs would be required to conduct site surveys to identify refrigerant-containing appliances that would be covered by the rule.

Comment: One commenter argued that technician and equipment shortages and complexity of supermarket systems will make compliance with the one-year retrofit or retirement requirements difficult. The commenter also stated the retrofits complying with the 2023 Technology Transitions Rule will further complicate compliance with the rule's deadline. Thus, the commenter asserts that owners or operators will incur significant excess costs to meet the retrofit or retirement requirements in the rule.

Response: EPA disagrees that 12 months is not enough time for an owner or operator to implement their retrofit or retirement plan as required under this rule, and further notes that the rule allows owners or operators to seek extensions if certain criteria are met. Owners or operators have up to 30 days to repair commercial refrigeration appliances (or 120 days if an industrial process shutdown is required) and extensions can be requested if certain criteria are met. During the leak repair process an owner or operator would know if a refrigerant-containing appliance is unable to be repaired and would therefore require retrofit or retirement. As discussed in section IV.A.2, EPA under the definition of "retrofit" being finalized in this rule, retrofitted refrigerant-containing appliances will not be required to transition to lower-GWP alternatives. The Agency, however, still encourages owners or operators that are retrofitting refrigerant-containing appliances to transition to a lower-GWP refrigerant. Further, in response to the commenter's concerns with complying with the 2023 Technology Transitions Rule, we note that restrictions on retrofits are not included in that rule and thus disagree with the commenters' assertion that that rule would complicate compliance with this rule's deadlines for retrofit or retirement plans. Additionally, the Agency notes that the commenter did not provide detailed information or data to support—or to allow EPA to more fully assess—the commenter's claims regarding potential technician and equipment shortages and how these factors would affect compliance with the retrofit and retirement requirements in the final rule or lead to excess costs.

Comment: The commenter recommended that EPA follow CARB's leak repair timeline of 14 days from the initial detection of the leak to ensure that any detected leak is repaired in a timely fashion because this approach reduces both emissions and additional refrigerant costs to appliance owners and operators.

Response: EPA agrees that the quicker a leak is repaired, the more emissions and additional refrigerant costs would be mitigated (up to the time that the entire charge has leaked out). EPA does not agree with the commenter that it would be appropriate to establish a 14-day repair timeline for the requirements in this rule. The amount of time provided to repair a leak and the reasoning for that decision is provided in section IV.C.3.b of this preamble. For analysis purposes, as explained in the RIA addendum and Economic Impact and Benefits TSD, EPA estimated that leaks would be noticed and repaired early due to the provisions of this rule.

Comment: Another commenter expressed support for EPA's proposed leak detection and repair requirements. The commenter noted that these proposed requirements will have positive benefits for the atmosphere and climate and will help ease demand for servicing gas.

Response: EPA agrees that leak detection and repair requirements will have a beneficial impact on the environment and has provided estimated benefits of these impacts in the Economic Impact and Benefits TSD. EPA agrees that the detection and repair of leaks is effective in reducing the quantity of gas necessary for servicing existing equipment.

Comment: One commenter stated that EPA significantly underestimated the costs of installing ALD systems. The commenter stated that EPA's cost estimates for direct ALD systems do not include all the types of costs that owners or operators will incur. The commenter recommended that EPA develop cost estimates that also consider the following:

- reviewing the ALD system requirements,
- preparing the process design for equipment installation, which includes safety and electrical reviews,
- preparing bid packages and reviewing bids,

- developing detailed mechanical designs (which would include the hardware/software needed to tie the systems to control houses and panels that may need to be modified),
- project cost estimating,
- management reviews,
- construction contracting,
- field installation, and
- testing.

With regards to indirect ALD systems, the commenter noted that EPA indicated that indirect systems have been installed in some retail stores but did not provide any information on applications in industrial facilities. The commenter suggested that the cost estimate for indirect ALD systems is orders of magnitude below what the actual costs will be. The commenter also expressed concern that the TSD for ALDs did not include any references to discussions with equipment suppliers about actual fully installed appliances and recommended that EPA take steps to develop more realistic costs estimates before finalizing the proposed rule. The commenter also stated that EPA's reference for the cost estimates (Abt Associates, Supplemental Automatic Leak Detect System Draft Analysis, 2023, prepared for EPA Stratospheric Protection Division) was not included in the Docket.

Response: EPA responds that the commenter did not provide information on how costs associated with the installation of direct ALD systems apply nor did the commenter provide estimates of such costs. Regarding the commenter's arguments on indirect ALD systems, EPA notes that the information provided on indirect systems installed in some retail stores was exemplary only and was not intended to represent all such installations. EPA provides information on the industries potentially affected by this rule both in the preamble to the proposed rule and the preamble to the final rule. A list by NAICS codes is also available in Appendix J of the RIA addendum. A full list of applications in any subsector of the industry is not plausible and not required for this rule; owners and operators whose equipment falls under the scope of the requirements (*e.g.*, full charge size of 1,500 pounds or more, installed on or after January 1, 2017) are required to install an ALD in the time frame set out by the final rule. The Agency reiterates that estimates in the RIA addendum and Economic Impact and Benefits TSD were provided for informational purposes and to comply with Executive Orders; the decision to require ALD system for certain appliances and allow owners or operators to choose whether to use a direct or indirect system, as explained in section IV.D of this preamble, serves the purposes described in subsection (h)(1), including the purpose of minimizing the release of regulated substances from equipment.

EPA notes that while the commenter utilizes EPA's cost estimates to argue for a change from the proposed requirements elsewhere, EPA provided this TSD for stakeholders for their information. In addition, EPA notes that the commenter did not provide specific information on "realistic" costs that the commenter would have EPA incorporate into the final RIA. We note that the scope of applicability for the ALD requirement has been reduced from the proposal; specifically, only appliances installed on or after January 1, 2017, are required to install an ALD. Further, the time by which the ALD must be installed has been set back. Furthermore, the reasons for the requirements for ALD system, as explained in section IV.D of this document, are not based on keeping below any specific cost; rather, it is based on serving the purposes described in subsection (h), as previously stated. Further discussion on the Agency's rationale for requiring the use of ALD systems for certain refrigerant-containing appliances can be found in section I.V.D. In reference to the comment regarding EPA's numbers used in *Table 3-3 Unit Cost Assumptions* found in the RIA addendum, EPA acknowledges the cited source was not included in the docket and has docketed the document and corrected the citation.

Comment: A commenter argued for a 2,000-pound threshold if EPA maintains the ALD installation requirement for some appliances The commenter asserted that EPA's RIA suggested that thresholds below 2,000 ponds are not cost-effective. The commenter also argued EPA should further evaluates the cost-effectiveness of threshold higher than 2,000 pounds and, at a minimum, should not finalize any threshold below 2,000 pounds.

Response: As discussed further in section IV.D of this preamble, the Agency is finalizing the 1,500-pound threshold for IPR and commercial refrigeration appliances containing an HFC or substitute for an HFC with a GWP greater than 53 as proposed. In the RIA addendum and Economic Impact and Benefits TSD for the proposed rulemaking, the Agency provided information on the costs and benefits of choosing a different threshold; however, we note that the figures presented in RIA are for informational purposes and not used as a record basis for deciding the threshold for ALD installation requirements. When deciding the charge size threshold for IPR and commercial refrigeration appliances subject to this provision EPA considered the relative risks of leaks from larger refrigerant-containing appliances and the supply of ALD systems to facilitate compliance with the provision. With those considerations, EPA finds the 1,500-pound threshold appropriate for serving the purposes described in subsection (h)(1), including the purpose of minimizing the release of regulated substances from equipment.

Comment: A commenter stated that the proposed rule would require carriers in the commercial airline industry who maintain large chiller systems at airports to install ALD systems at high costs.

Response: EPA disagrees with the commenter's assertions and notes that the commenter did not provide any information or data to support their assertions regarding the effects of the costs associated with the installation of ALD systems for chillers at airports on the commercial airline industry, nor did they provide any information indicating how or why EPA should change the proposed rule to account for these costs.

Comment: A commenter argued that mandating leak searches and adding ALD further adds to consumer costs.

Response: EPA responds that the commenter did not provide sufficient information to describe why or how the costs related the leak repair and ALD requirements would lead to more costs and thus be passed onto consumers. EPA understands that refrigerant and the maintenance of refrigerant systems are a small percentage of the overall costs of owning such refrigerant-containing appliances. The effective repair of leaks and the discovery of leaks faster via ALD systems will lead to more cost savings for owners and operators, as properly functioning refrigerant-containing appliances are more energy efficient and require fewer refrigerant additions.

Comment: One commenter suggested that EPA provided no proof that "bolstering the current supply of HFCs with recovered and reclaimed refrigerants from existing systems, reclamation can support a smooth transition to substitutes for HFCs, minimize disruption of the current capital stock of equipment by allowing its continued use with existing refrigerant supplies, avoid supply shortages of virgin refrigerants, and can insulate the industry against price spikes that could affect the servicing of existing systems using HFCs" can be achieved. The commenter also claimed that EPA's claims of cost-savings are contradicted by the RIA, which did not monetize any of the supposed benefits.

Response: EPA disagrees with the commenter and directs the reader to section IV.E of this preamble for additional information on the reclamation requirements. EPA notes that there was a 40 percent increase in the mass of HFCs reclaimed from 2021 to 2022 which may be an indication that there will be additional shifts in the reclamation market.[156] In EPA's experience with the CFC and HCFC phaseouts, we have seen continued use of reclaim, indicating that equipment was and, in many cases, still is operating utilizing refrigerants that have been phased out. Throughout those phaseouts, EPA has not seen any significant disruption or premature retirement of equipment due to refrigerant shortages, nor did the commenter provide any evidence thereof.

In the RIA addendum and Economic Impacts and Benefits TSD, EPA has estimated the costs and benefits of the regulations. While the commenter seems to indicate that cost savings were not included in the analysis, EPA notes that cost savings associated with avoided refrigerant losses were included in the analysis conducted for both the proposed and final rule. More information on these assumptions can be found in section VI.B.2 of this preamble as well as the RIA Addendum and Economic Impacts and Benefits TSD.

Comment: One commenter stated that the modeling conducted in support of the AIM Act regulations appears to rely on refrigerant recovery in disposal and servicing of appliances that may exceed what current regulations will achieve. The commenter cited the RIA for the allocation regulation and the RIA for the 2023 Technology Transitions rule, on the basis of which the commenter stated their understanding that EPA may expect a 100 percent recovery rate. The commenter noted that despite the proposed rule's multiple measures, the proposal has

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[156] EPA Refrigerant Reclamation Summary 2000-2022. Available at: *https://www.epa.gov/system/files/documents/2023-12/2022_reclamation_table.pdf*

few provisions regarding the disposal side of refrigerant recovery or the recovery of refrigerants at the EOL. The commenter stated that residential EOL disposal and recovery is not discussed in EPA reclaim market report provided in the docket, but residential appliances are an important source of HFC consumption and emissions. The commenter shared a concern that there is little incentive for individuals that may collect residential appliances, such as from a curbside, to properly recover refrigerants before transferring the equipment to a recycling or other disposal facility, and stated that entities that accept EOL equipment, like metal recovery facilities, may request that refrigerant be vented prior to disposal so that they are not subject to regulation, creating a gap in enforcement of existing regulations and undermining reclaim supply. The commenter stated that of the jurisdictions with refrigerant collection policies, Japan may have the most recovery and Japan's government reports a 40 percent recovery rate. The commenter argued that based on information provided by EPA, the recovery rate in the United States is much lower than this and much lower than what may have been modeled in the AIM Act rulemakings. The commenter added that even the volume of HFCs contained within products exceeded the recovery rate in 2020 by seven times. The commenter further noted that one benefit of the proposed regulation is that by increasing the demand for reclaim, it also provides additional incentive for refrigerant recovery. However, the commenter stated that based on the industry report provided by EPA in the docket, the examples from other jurisdictions suggest that incentives are not enough to ensure a high rate of recovery. The commenter stated that EPA's modeling assumptions may only be achievable through robust enforcement and incentives.

Response: EPA confirms that the modeling conducted for the RIA and RIA addenda for the HFC Allocation and 2023 Technology Transitions rules do assume improvements to refrigerant recovery rates, during service and at disposal, in the potential compliance pathway.

However, the rate of recovery assumed in this modeling was not 100%. To represent improvements to refrigerant recovery rates expected under the provisions of this final rule, EPA modeled an improvement in the emissions rate of equipment at disposal. Specifically, it was assumed that an emissions rate of 3 to 4 percent would be achieved for large and small RACHP equipment (in other words, 3-4 percent of equipment charge would still be emitted at EOL even with the improved recovery assumption). EPA notes that while this assumption was included in the compliance path for the Allocation Rule RIA, it was effectively treated as an uncertainty in the subsequent 2023 Technology Transitions RIA addendum, given that updated modeling results demonstrated that compliance with both rules could be achieved without improved recovery. As detailed in the RIA addendum for the final ER&R rule, modeling conducted for this rule assumes that the prior improved recovery assumption would occur in the "baseline" in order to provide a conservative depiction of benefits attributable to this rule. However, an alternative scenario has also been provided in the RIA addendum in which improved recovery is not assumed to otherwise occur in the absence of this regulation, thus illustrating higher potential incremental benefits. EPA welcomes additional data and technical information on this topic and will continue to monitor industry recovery and reclamation rates in order to potentially update its modeling assumptions in the future. Finally, EPA acknowledges that further improvements in recovery rates may be achievable through enforcement and incentives such as those mentioned by the commenter.

Comment: One commenter stated that EPA is uncertain whether mandating the use of reclaimed HFCs would provide benefits in the form of additional HFC reductions. The commenter stated that EPA indicates that use of reclaimed HFCs in the RACHP subsector and fire suppression equipment "may not yield significant additional HFC consumption reductions, relative to what was previously modeled in the Allocation Framework Rule Reference Case," while noting that EPA states that the "specific provision of this proposed rule would likely increase the use of recycled/reclaimed HFCs beyond what was already accounted for in [the RIA]." The commenter claimed that EPA offers no quantification of this increase, and that such imprecise and qualified impacts do not provide a sufficient policy basis for the imposition of requirements that will impact the HFC market as envisioned by the AIM Act.

The commenter also argued that the proposed rule would create a captive market as opposed to one based on competition, thereby losing any economic incentives that could lower the cost of products to consumers. The commenter stated that EPA effectively requires OEMs to buy reclaimed HFCs in order to sell pre-charged HVACR equipment and technicians and others to buy reclaimed HFCs in order to "first fill" new equipment on-site. The commenter claimed that this creates a closed market given the finite amount of reclaimed HFCs available, citing EPA's 2023 reclaim report documenting that 1,600 MT of R-410A was available in 2022 as reclaim, which the commenter claimed, relative to estimated 2022 demand for charging new R-410A AC equipment, represents less than 4 percent of new equipment demand. The commenter further argued that in its analysis for the proposed rule, EPA has not considered that the finite amount available in 2022 was likely already sold, leaving other newly obligated parties to purchase required reclaimed HFCs from a market that already has a minimum value established for R-410A. The commenter claimed that this necessarily results in an unbalanced, artificial market of EPA's creation. The commenter also stated that EPA hasn't analyzed the cost impact of such market conditions to the end consumer nor any potential adverse outcomes, including concentration of a finite amount of reclaimed HFCs within a relatively small number of suppliers.

The commenter also claimed that EPA utilizes "regulatorily manufactured demand" to estimate actual demand for initial charge of reclaimed HFCs in 2028 at 23,300 metric tons, and that by doing so EPA did not establish a "no action" base analysis. Instead, EPA forecasted existing demand by creating reclaim requirements meant to create this "artificial demand." The commenter then stated that EPA made a faulty assumption in assuming that market forces would not be sufficient to increase reclamation before the next phasedown of HFC production and consumption. The commenter claimed that EPA erroneously concluded that voluntary reclamation programs that "worked in Europe" would not be sufficient to increase reclamation in the U.S, and that EPA's decision to institute regulations to increase reclamation are "at variance with the AIM Act… [and] arbitrary and capricious."

The commenter further stated that reclaim requirements for HFCs are also unnecessary based on the United States' experience with the phaseout of ODS, as a reclamation market has allowed the continued use of ODS even in the absence of voluntary reclamation requirements. Furthermore, the commenter stated that the climate impact of refrigerant leaks is the same regardless of whether refrigerant is reclaimed or virgin, and that EPA has no basis for claiming that there will be a climate benefit from reclamation requirements or that reclamation will offset emissions from newly produced HFCs, either domestic or imported. The commenter stated that EPA's own analysis has not proven that increased reclamation will provide additional benefits, citing quotations from the RIA addendum. The commenter instead concluded that "market distortion" is the most likely outcome, with some parts of the HFC marketplace impacted more heavily than others.

The commenter additionally argued that the RIA is inadequate to support EPA's proposed direct intervention in the market. The commenter noted that EPA states in the RIA addendum that because "cost and emission estimates aren't available specifically in the United States context, cost savings and benefits are not directly incorporated into the overall compliance costs and benefit estimates associated with the rulemaking [provisions on reclamation]," and states that to account for the uncertainty in EPA's intervention in the market, EPA created two scenarios: (1) where requirements to use reclaimed HFCs result in a shift of the use of available consumption and production allowances; and (2) a 'high additionality' case where some abatement of HFCs is assumed. The commenter stated that EPA then measured the costs and benefits of reclamation using a highly flawed methodology, and that EPA calculated incremental cost difference of virgin production, destruction, and reclamation at $0.58 per kilogram. The commenter argued this methodology merely compared the cost of virgin production and destruction and then subtracted the cost of reclamation, and that this calculation is effectively meaningless in the context of what EPA actually proposed.

The commenter argued that this analysis showed that there is already a strong economic incentive to reclaim HFCs instead of destroying them, because the estimated cost of production is $0.24 versus $0.04 for reclamation. The commenter further stated that the cost calculated does not actually reflect EPA's proposal to substitute the use of reclaimed versus newly produced HFCs, and instead assumes that all newly produced HFCs would be destroyed without EPA's proposed mandatory use of reclaimed HFCs, which the commenter describes as nonsensical. The commenter claimed that for EPA's proposed use of reclaimed HFCs to have a market effect (*e.g.*, if it is assumed that reclaimed HFCs will offset the production of virgin HFCs) then new production should be offset by 1:1 (or some other, lesser ratio) but any newly produced HFCs would logically not be concurrently destroyed. Rather, the commenter argued, both the virgin HFC and the reclaimed HFC would eventually be destroyed, presumably at comparable rates, meaning that the calculated benefit of $0.58 would not exist along with any derived climate benefit.

The commenter further stated that to the extent that EPA calculated the quantity of emissions prevented it appears to have assumed that 15 percent of HFCs would still be produced for blending into reclaimed HFCs and another 67 percent of HFCs would be lost in the reclaim process and eventual emissions of reclaimed HFCs. The commenter argued that this would mean that EPA estimates that 18 percent of HFC production would be avoided due to the newly proposed requirements but claimed that EPA provided no basis for this assumption in the RIA. The commenter argued that any claimed benefits to the climate must therefore be discounted due to a lack of explanation as to how such would occur. The commenter further claimed that EPA has not conducted sufficient analysis, and that therefore it cannot simply conclude that such benefits would occur, as the commenter states EPA appears to do. The commenter stated that EPA provided no TSD to support its reclamation proposal, unlike TSDs for ALD, fire suppression, and the cold chain, that the study cited (Yasaka et al. (2023)) is not provided in the docket, and that an additional report cited by EPA does not contain relevant calculations. The commenter stated that, for example, EPA cited but does not provide in the docket a report entitled “The 90 Billion Ton Opportunity,” and that the available copy of this report on the web contains no calculations as to the amount of HFC releases avoided through mandatory reuse of HFCs.

Response: EPA responds that, upon consideration of comments, in light of the provisions being finalize, and because of further analysis, many of the analytic assumptions mentioned by the commenter have been updated in the final rule RIA addendum and Economic Impact and Benefits TSD. EPA acknowledges that there is uncertainty regarding the degree to which some of the provisions contained in this final rule will lead to incremental reductions in HFC consumption and emissions when considering already in-place regulations and market forces. For these reasons, EPA has included multiple scenarios in the RIA addendum for the final rule. However, as detailed in the RIA addendum, even in EPA's most conservative assessment of the incremental benefits of the final rule, significant incremental consumption and emissions reductions occur.

EPA disagrees that existing economic incentives for reclamation in the absence of this rulemaking would represent a flaw in the analysis. As noted elsewhere in the rule preamble, some market failure may exist that acts as a barrier to businesses' adoption of the most profitable course. For example, market failures may exist where there are imperfect information or split incentives, such as decision-makers not knowing the percentage of energy use associated with different options.

EPA notes that the commenter's assertions regarding the creation of potentially anticompetitive markets for reclaimed HFCs appear to be speculative. The commenter did not provide sufficient information to support their claims or analyze the specific details of their assertions, including information addressing how the rule would lead to such adverse outcomes given the numerous EPA-certified reclaimers that exist, and the opportunity for other entities to enter the reclaim market. Nor is EPA aware of such information or analyses in the record for this rule. In addition, EPA notes that the proposed requirements for "first fill" use of reclaimed HFC requirements for the RACHP sector were not finalized, thus potentially alleviating some the commenter's concerns. EPA has also responded to many of the commenter's concerns regarding the market for reclaimed HFCs and has described the rationale for the requirements for use of reclaimed material that are being finalized in this rule, in section IV.E.2 of this preamble.

Regarding a "no action" analysis, EPA notes that the Agency provided a "Business as Usual" scenario in the 2021 Allocation Framework Rule RIA addendum. EPA further notes that the commenter seems to misunderstand the reason for preparing the RIA addendum. As noted elsewhere in this preamble, while EPA has included estimates of the costs and benefits of this rulemaking in the RIA addendum, to provide the public with information on the relevant costs and benefits of this action and to comply with Executive Orders, the analysis in the RIA addendum does not form a basis or rationale for any of the provisions EPA is promulgating in this rulemaking.

Finally, in its analysis of the costs and benefits of this rule, EPA has not assumed that reclaimed HFCs are more cost-effective vis a vis virgin HFCs due to avoided destruction costs. Such an assumption may be defensible, and EPA is aware of the study, referenced by the commenter, indicating that reclaimed HFCs may actually be more cost-effective than virgin manufacture, when considering the full refrigerant lifecycle including destruction. While we referenced this study in the RIA addendum included with the proposed rule, for the final RIA addendum we have conservatively not included the potential savings cited by that study. Indeed, in its central base case analysis EPA has conservatively assumed a cost premium for reclaimed HFCs vis-a-vis virgin HFCs of 10 percent.

In response to the commenter's claim that EPA should implement a voluntary refrigerant reclamation program instead of promulgating refrigerant regulations, EPA responds that the Agency is finalizing reclamation requirements to implement subsection (h)(1) and subsection (h)(2)(B) of the AIM Act, as stated in IV.E.1. Namely, EPA instituted reclamation provisions in order to maximize reclamation and minimize releases of HFCs consistent with (h)(1), and also to implement subsection (h)(2)(B) of the AIM Act, which provides that a regulated substance used as a refrigerant shall be reclaimed before being sold or transferred to a new owner, except where such sale or transfer is solely for purposes of reclamation or destruction of the regulated substance. The commenter fails to provide any information or analysis to support a conclusion that a voluntary reclamation program would be as well suited to meeting the objectives of this rule as the program that EPA is establishing in this rule.

In response to the commenter's assertions regarding docketing, EPA included both sources that the commenter mentioned in the docket. Yasaka et al. (2023) is included in the docket as an attachment to the docket entry for the RIA addendum,[157] while the study the commenter cites "The 90 Billion Ton Opportunity" is included in a docketed list of references from the NPRM.[158]

Comment: Another commenter stated that EPA did not clearly and consistently identify the heel estimates used when assessing potential benefits of the proposed cylinder management requirements. The commenter stated that EPA's environmental benefit analysis is contradictory, insufficiently supported, and does not rely on facts.

Response: EPA has included information in the RIA addendum and Economic Impact and Benefits TSD for the final rule regarding the assumptions, including the estimated heel, used in our analysis of the costs and benefits of the requirements for the management of disposable cylinders. Further, based on information from the commenter, we have provided sensitivity analyses of the related costs and benefits in Appendix K of the RIA addendum.

[157] The docket entry for the RIA Addendum for the proposed rule is available at: *https://www.regulations.gov/document/EPA-HQ-OAR-2022-0606-0023*, and the Yasaka study is attachment 17.
[158] The docket for materials referenced in the proposed rule is available at: *https://www.regulations.gov/document/EPA-HQ-OAR-2022-0606-0015*

Comment: One commenter stated that there would be no benefit for reclaimers to recover refrigerant heels because there would be little refrigerant left in the cylinders, resulting in an expensive refrigerant from a cost per ounce perspective. Another commenter stated that EPA's RIA addendum did not provide any estimates of the costs and benefits of the proposed container tracking system. The commenter stated that EPA cost estimates appear to be entirely based on the separate requirement regarding the recovery of cylinder heels.

An additional commenter stated that there is no benefit to forcing empty disposable cylinders to outside facilities and that tracking cylinders will increase costs.

Response: EPA has estimated the costs and benefits of requirements to manage disposable cylinders and heels in the RIA addendum and Economic Impact and Benefits TSD for the final rule. EPA is not finalizing the cylinder tracking requirements at this time, and thus costs related to those provisions are not included in the costs from the aforementioned RIA addendum and TSD. We note that for consistency with previous regulation under the AIM Act, we assumed the value of the recovered heel is $4 per pound. That said, we expect that given the HFC phasedown that is underway, those costs could increase over time, providing more value to those recovering the heels. The reasons for establishing these requirements related to disposable cylinders and heels are explained in section IV.G of this document.

Comment: One commenter also stated that there will be a cost impact throughout the supply chain to handle the logistics and tracking required to recover a likely small amount of HFCs. The commenter expressed concern with the net environmental impact of reclaiming the heel refrigerant from disposable cylinders in the MVAC sector after considering the transport, handling, and reclamation energy required to extract the remaining refrigerant, and the commenter urged EPA to consider all factors involved in the net environmental benefit of heel reclamation before implementing the rule.

Response: EPA has estimated the costs and benefits of the requirements to manage disposable cylinders and send heels for reclamation in the RIA addendum and Economic Impact and Benefits TSD for the final rule. EPA's assessment included additional costs related to transport and the labor costs, plus overhead, for handling and transporting such cylinders. While we acknowledge there are energy use implications in reclaiming materials, we noted in the draft RIA addendum to the proposed rule a study (Yasaka et al., 2023)[159] that shows, overall, the use of reclaimed refrigerant leads to net reductions in energy compared to the production of virgin material. To be conservative and because these results were based on data from Japan and Europe, we do not, however, use those findings to increase the benefits assessed from the avoided emissions estimated based on the requirements of the final rule.

Comment: One commenter suggested that the proposed cylinder management and tracking requirements do not appear to be based on a complete and legally sufficient analysis of the best available data. As such, the commenter stated that that EPA may have significantly overstated the environmental benefits. Another commenter expressed concern that the proposed rule requiring machine readable tracking identifiers on all containers of HFCs that could be used for the servicing, repair, or installation of refrigerant containing equipment, including both refillable and disposable cylinders, and the requirement to record specific data during the movement of these cylinders will impose significant costs and investment by all industry stakeholders.

[159] Yasaka, Yoshihito, et al. "Life-Cycle Assessment of Refrigerants for Air Conditioners Considering Reclamation and Destruction." Sustainability, vol. 15, no.1, 2023, p. 473, doi:10.3390/su15010473.

Response: EPA responds that it is not finalizing the cylinder tracking requirements at this time, and thus costs and benefits related to those provisions are not included in the RIA addendum and the Economic Impact and Benefits TSD for the final rule. EPA has explained the data used to assess the costs and benefits of the requirement to manage disposable cylinders and send heels to reclaimers in the RIA addendum and the Economic Impact and Benefits TSD. Further, EPA has used *information* provided by the commenters to perform sensitivity analyses of our estimate, and notes that in all cases examined, there are environmental benefits, and the savings outweigh the costs even without considering the monetized climate benefits (*i.e.*, even without applying SC-HFC values to the emission reductions). However, as noted previously in this preamble, while EPA included estimates of the costs and benefits of this rulemaking in the RIA addendum to provide the public with information on the relevant costs and benefits of this action and to comply with Executive Orders, the analysis in the RIA addendum does not form a basis or rationale for any of the provisions EPA is promulgating in this rulemaking. Further, although EPA is using the SC-HFCs for purposes of some of the analysis in the RIA addendum, this action does not rely on those estimates of these costs as a record basis for the Agency's action. EPA would reach the conclusions in this rule even in the absence of the SC-HFCs. EPA's reasons for establishing the requirements related to disposable cylinders are explained in section IV.G of this preamble.

Comment: Another commenter stated that the container requirements would likely have the greatest impact on the smallest firms in the industry with the fewest resources to spare. The commenter stated that any increased costs associated with the container provisions will ultimately be passed on to consumers, regardless of whether the initial impact is absorbed by contractors or distributors.

Response: In Appendix G of the RIA addendum, EPA performed an assessment under the guidelines of the Small Business Regulatory Enforcement Fairness Act of 1996 and found that the rulemaking can be presumed not to have a significant economic impact on a substantial number of small entities (SISNOSE). Further, to the extent that the comment pertains to the proposed cylinder tracking requirements, EPA notes that it is not finalizing the cylinder tracking requirements at this time.

Comment: One commenter suggested that the implementation of the proposed rule's requirements would unduly burden disadvantaged communities. The commenter stated that it may not be economically viable to retrofit, retire, or replace an existing system to comply with the mandates in the proposed rule due to the complex and integrated nature of grocery store refrigeration systems. The commenter also mentioned that rural and poor communities are more likely to have older stores with older systems that leak at a higher rate than average and with tighter profit margins that make it hard for store owners to pay for extensive repairs, retrofits, or replacements of their refrigeration systems. Additionally, the commenter stated that expenses associated with system maintenance under the proposed requirements would also increase the chances that store owners would be unable to keep less profitable stores open and those stores that remain open would be forced to raise food prices in disadvantaged areas and, in some situations, exacerbate the "food desert" problem in certain areas of the country.

The commenter also stated that the proposed requirements to use only reclaimed refrigerants would push additional costs onto the retail food sector that is already struggling due to low profit margins and inflation. The commenter claimed that these high costs may also cause more frequent and longer repairs which leads to store shutdowns, greater food safety risk, and potential removals of refrigerated sections altogether. The commenter argued that that such an increased financial burden will likely impact older stores, and those either owned by or residing in minority and already economically stressed communities.

Another commenter stated that the premature retirement of certain equipment would lead to a disproportionate burden on poorer communities that are unable to replace their equipment. The commenter stated that EPA did not evaluate the implications of this part of its proposed rule on poorer communities and users. The commenter further stated that these issues and the environmental burdens caused by disposal of prematurely obsolete equipment should also be considered.

Another commenter stated that EPA must analyze how increased costs on the baking sector and other food production sectors that use refrigeration will contribute to increased food price inflation and basket of goods impacts generally. The commenter stated that EPA must also analyze how these increased cost pressures might impact food prices cumulatively when considered together with what they characterized as other inflationary pressures, such as EPA's biodiesel and renewable diesel mandates under the Renewable Fuel Standard Program (RFS).

Response: EPA recognizes the importance of the food cold chain and food retailers servicing various communities, including avoiding food deserts. However, EPA disagrees that the requirements finalized in this rule will result in undue burden and store closures or the loss of access to food. Store owners may replace broken or inefficient HFC components and save money by repairing leaks in their existing systems. With regards to the comments concerning passing on costs by raising the prices of retail food, EPA reiterates the overall HFC phasedown will impact the costs of HFC refrigerants in the future. The commenter did not provide detailed information on how specific elements of this rule would result in costs that would be passed on to the consumer and in particular how that would differ from the longstanding ODS requirements or existing HFC requirements. Additionally, some of the requirements in this final rule have been modified from the proposal, and some of those modifications have the effect of easing burden. For example, the requirements for ALD systems include those existing commercial refrigeration equipment with charge sizes of 1,500 pounds or more that were installed on or after January 1, 2017, whereas the proposal included all existing systems with charge sizes of 1,500 pounds or more. Overall, the refrigerant management provisions help to maintain the health of appliances. This can be crucial for refrigerant-containing appliances in the RACHP subsectors that are relevant to handling food products, such as supermarket systems, where the intended function is to ensure food products are maintained at appropriate temperatures to avoid spoilage and food waste. Successful repair of leaks and avoiding leaks are a few ways to help ensure that these appliances are operating efficiently and as intended and can help to avoid unnecessary food waste.

EPA appreciates concern over food costs, however with the delayed compliance dates for the reclaim requirements, the Agency anticipates that this will give the market time to adjust to the changes. In the RIA addendum, EPA conservatively assumed that reclaimed refrigerant would cost 10 percent more than virgin refrigerant. Based on consideration of a public comment from a reclaimer stating that virgin and reclaimed refrigerant are the same price, we have also included a sensitivity analysis under that assumption.

In response to the comment on the baking sector, the commenter did not provide, sufficient information to support their claims or analyze the specific details of their assertion that the "rule will contribute to increased food prices and basket of goods impacts generally." Nor is EPA aware of such information or analyses in the record for this rule. EPA estimated the overall costs and benefits of the rule in the RIA addendum and the Economic Impact and Benefits TSD, and to the extent the baking sector is affected by the rule, those estimates include those costs and benefits that will be directed towards that sector. Evaluation of "other inflationary pressures," including the commenters' assertions of such impacts from the Renewable Fuel Standard, is outside of the scope of this rulemaking and so is not included in the RIA addendum or the Economic Impact and Benefits TSD.

VII. How is EPA considering environmental justice?

As part of the RIA addendum for the final rulemaking, EPA updated the environmental justice analysis that was previously conducted for the proposed rule. The updated environmental justice analysis used the same analytical approach used previously, along with the addition of more reclamation facilities identified since publication of the proposed rule.

EO 12898 (59 FR 7629, February 16, 1994) and EO 14008 (86 FR 7619, January 27, 2021) establish federal executive policy on environmental justice. EO 14096, signed April 21, 2023, builds on the prior EOs to further advance environmental justice (88 FR 25251).

EO 12898's main provision directs federal agencies, to the greatest extent practicable and permitted by law, to make environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on people of color and low-income populations in the United States. EPA defines[160] environmental justice as the just treatment and meaningful involvement of all people, regardless of income, race, color, national origin, tribal affiliation, or disability, in agency decision-making and other Federal activities that affect human health and

[160] EPA recognizes that EO 14096 (88 FR 25251, April 21, 2023) provides a new terminology and a new definition for environmental justice. For additional information, see *https://www.federalregister.gov/documents/2023/04/26/2023-08955/revitalizing-our-nations-commitment-to-environmental-justice-for-all*.

the environment so that people: (i) are fully protected from disproportionate and adverse human health and environmental effects (including risks) and hazards, including those related to climate change, the cumulative impacts of environmental and other burdens, and the legacy of racism or other structural or systemic barriers; and (ii) have equitable access to a healthy, sustainable, and resilient environment in which to live, play, work, learn, grow, worship, and engage in cultural and subsistence practices.[161] Meaningful involvement means that: (1) potentially affected populations have an appropriate opportunity to participate in decisions about a proposed activity that will affect their environment and/or health; (2) the public's contribution can influence the regulatory Agency's decision; (3) the concerns of all participants involved will be considered in the decision-making process; and (4) the rule-writers and decision-makers seek out and facilitate the involvement of those potentially affected.[162] The term "disproportionate impacts" refers to differences in impacts or risks that are extensive enough that they may merit Agency action. In general, the determination of whether there is a disproportionate impact that may merit Agency action is ultimately a policy judgment which, while informed by analysis, is the responsibility of the decision-maker. The terms "difference" or "differential" indicate an analytically discernible distinction in impacts or risks across population groups. It is the role of the analyst to assess and present differences in anticipated impacts across population groups of concern for both the

[161] See, *e.g.*, Environmental Protection Agency. "*Environmental Justice*." Available at: *https://www.epa.gov/environmentaljustice.*

[162] The criteria for meaningful involvement are contained in EPA's May 2015 document "*Guidance on Considering Environmental Justice During the Development of an Action*." Environmental Protection Agency, 17 Feb. 2017. Available at: *https://www.epa.gov/environmentaljustice/guidance-considering-environmental-justice-during-development-action*.

baseline and regulatory options, using the best available information (both quantitative and qualitative) to inform the decision-maker and the public.[163]

EO 14008 calls on agencies to make achieving environmental justice part of their missions "by developing programs, policies, and activities to address the disproportionately high and adverse human health, environmental, climate-related and other cumulative impacts on disadvantaged communities, as well as the accompanying economic challenges of such impacts." EO 14008 further declares a policy "to secure environmental justice and spur economic opportunity for disadvantaged communities that have been historically marginalized and overburdened by pollution and under-investment in housing, transportation, water and wastewater infrastructure, and health care."

In addition, the Presidential Memorandum on Modernizing Regulatory Review calls for procedures to "take into account the distributional consequences of regulations, including as part of a quantitative or qualitative analysis of the costs and benefits of regulations, to ensure that regulatory initiatives appropriately benefit, and do not inappropriately burden disadvantaged, vulnerable, or marginalized communities."[164] EPA also released its June 2016 "Technical Guidance for Assessing Environmental Justice in Regulatory Analysis" (2016 Technical Guidance) to provide recommendations that encourage analysts to conduct the highest quality

[163] The definitions and criteria for "disproportionate impacts," "difference," and "differential" are contained in EPA's June 2016 document "Technical Guidance for Assessing Environmental Justice in Regulatory Analysis." Available at: *https://www.epa.gov/environmentaljustice/technical-guidance-assessing-environmental-justice-regulatory-analysis.*

[164] Presidential Memorandum on Modernizing Regulatory Review, January 20, 2021. Available at: *https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/modernizing-regulatory-review/.*

analysis feasible, recognizing that data limitations, time and resource constraints, and analytic challenges will vary by media and circumstance.[165]

For this action, EPA conducted an environmental justice analysis[166] using a methodology similar to that we used as part of the Allocation Framework Rule (86 FR 55116, October 5, 2021). The information provided in this section is for informational purposes only; EPA is not relying on the information in this section as a record basis for this action. EPA evaluated communities surrounding the 38 identified HFC reclamation facilities and followed the analytical approach used in the Allocation Framework Rule RIA. This update uses information from the AirToxScreen 2019 dataset.

The analysis shows that communities near the 38 identified HFC reclamation facilities are generally more diverse than the national average with respect to race and ethnicity. While the median income of these communities is slightly higher than the national average, there are more low-income households. Across the 38 facilities, total respiratory risk and total cancer risk are lowest for the communities nearest the reclamation sites. While the total respiratory index for communities within one mile of these 38 facilities are slightly higher than the national average (.34 compared to the national average of .31), the risk for those closest to the facilities appears smaller than for those at greater distances (5- and 10-mile radii).

This rule is expected to result in benefits in the form of reduced GHG emissions. The analysis conducted for this rule also estimates that a portion of these benefits would be

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[165] Technical Guidance for Assessing Environmental Justice in Regulatory Analysis, June 2016. Available at: *https://www.epa.gov/sites/default/files/2016-06/documents/ejtg_5_6_16_v5.1.pdf.*

[166] EPA recognizes that new terminology and a new definition for environmental justice were established in EO 14096 (88 FR 25251, April 21, 2023). When the analysis of the proposed rule was performed, EPA was operating under prior guidance available here: *https://www.epa.gov/sites/default/files/2015-06/documents/considering-ej-in-rulemaking-guide-final.pdf.*

incremental to emissions reductions that were anticipated under the Allocation Framework Rule and the 2023 Technology Transitions Rule, thus further reducing the risks of climate change.

While providing additional overall climate benefits, this rule may also result in changes in emissions of air pollutants or other chemicals which are potential byproducts of HFC reclamation processes at affected facilities. The market for reclaimed HFCs could drive changes in potential risk for communities living near these facilities, but the changes in emissions that could have local effects are uncertain. Further, the nature and location of the emission changes are uncertain. Moreover, there is insufficient information at this time about which facilities will change reclamation processes. Given limited information at this time, it is unclear to what extent this rule will impact existing disproportionate adverse effects on communities living near HFC reclamation facilities.[167] The Agency will continue to evaluate the impacts of this rulemaking on communities with environmental justice concerns and consider further action, as appropriate, to protect health in communities affected by HFC reclamation.

Comment: One commenter expressed support for EPA's approach on environmental justice and noted that ensuring safety for technicians and consumers will benefit all end users. The commenter noted areas for EPA's consideration regarding impacts on low- and medium-income families in its comments, including allowing some flexibility with retrofit and retirement

[167] Statements made in this section on the environmental justice analysis draw support from the following citations: Banzhaf, Spencer, Lala Ma, and Christopher Timmins. 2019. Environmental justice: The economics of race, place, and pollution. Journal of Economic Perspectives; Hernandez-Cortes, D. and Meng, K.C., 2020. Do environmental markets cause environmental injustice? Evidence from California's carbon market (No. w27205). NBER; Hu, L., Montzka, S.A., Miller, B.R., Andrews, A.E., Miller, J.B., Lehman, S.J., Sweeney, C., Miller, S.M., Thoning, K., Siso, C. and Atlas, E.L., 2016. Continued emissions of carbon tetrachloride from the United States nearly two decades after its phaseout for dispersive uses. Proceedings of the National Academy of Sciences; Mansur, E. and Sheriff, G., 2021. On the measurement of environmental inequality: Ranking emissions distributions generated by different policy instruments.; U.S. EPA. 2011. Plan EJ 2014. Washington, DC: U.S. EPA, Office of Environmental Justice.; U.S. EPA. 2015. Guidance on Considering Environmental Justice During the Development of Regulatory Actions. May 2015.; USGCRP. 2016. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. U.S. Global Change Research Program, Washington, DC.

requirements and considering using some of EPA's budget to fund the purchase of recovery equipment for small contractors serving low- and medium-income communities.

Response: EPA acknowledges the commenter's general support for the approach the Agency has taken for its environmental justice analysis. EPA acknowledges the commenter's suggestion that portions of the Agency budget be redirected to support the purchase of recovery equipment. The Agency notes that to date, funds have not been appropriated for such a purpose. EPA clarifies that leak repair requirements do not apply to residential RACHP equipment, and that EPA is not requiring refrigerant-containing appliances to be retrofitted to a lower-GWP refrigerant.

Comment: One commenter stated that there needs to be greater awareness of the environmental impacts for those who work with HFC refrigerants and to those who advocate for environmental justice.

Response: EPA acknowledges the commenter's support for greater awareness of environmental impacts in this area. EPA notes that the discussion of environmental justice in this action may help increase awareness of these issues.

VIII. How is EPA responding to other comments on the proposed rule?

Comment: One commenter stated there is no authority in the AIM Act (or in the CAA) for mandating facilities install leak detection systems to be used in the normal operation of equipment between servicing. The commenter stated that the Agency's assertion that leak detection is "an activity regarding the servicing or repair of equipment" stretches the actual languages used by Congress beyond their intent and cannot be legally supported. The commenter also mentioned that EPA does not have the authority to penalize facility owners (or equipment owners) for mismanagement of refrigerant resulting from errors made by certified service providers, nor does EPA have the power to regulate loss of refrigerant during normal operations. While the commenter generally agreed with EPA's regulation and best practices for technicians, they claimed the proposed rule does not indicate how that authority extends to the regulation of facility owners. Accordingly, the commenter stated the Agency legally may only require leak detection and prevention during the time that service providers are maintaining refrigeration systems. Further, the commenter stated that EPA has previously recognized that refrigeration equipment will inherently lose refrigerant charge over time and that refrigeration and air conditioning equipment does often leak. If taken to its logical conclusion, the overly broad interpretation of the section 608 rules and the proposed rule to encompass normal operation, in theory, would also extend liability to equipment manufacturers whose appliances would violate the venting prohibition by merely selling equipment into commerce because the equipment might leak and require replacement of refrigerant. Thus, EPA lacks authority to impose liability for normal operation of refrigeration equipment, it cannot impose liability for replacement of refrigerant that is lost routinely during normal operation.

Another commenter stated that EPA should acknowledge that the Agency has no authority under the AIM Act or CAA section 608 to penalize facility or equipment owners for management of refrigerant resulting from errors made by service providers or regulate the loss of refrigerant during normal operations. The commenter cites the use of the term "maintenance" in section 608(c), but not in 608(a), as justification that Congress intended EPA to regulate servicing of equipment by technicians, rather than equipment by facility owners. The commenter further stated that if section 608 is interpreted to encompass normal operation of equipment, an equipment manufacturer would violate the venting prohibition by selling equipment into commerce, because their equipment might leak. Further, the commenter stated that if EPA lacks authority to “impose liability for normal operation of refrigeration equipment” the Agency cannot hold others liable for replacement of refrigerant that is lost in routine operation. The commenter concluded that EPA’s authority is limited under section 608 to regulating “intentional or negligent venting” by service providers during servicing, and that the same applies to EPA’s authority under the AIM Act.

The commenter claimed that even if EPA could impose penalties for refrigerant release during normal operation, section 608 and subsection (h) do not enable EPA to impose monetary penalties on facilities owners, unless the owner was using its own personnel to service equipment. The commenter cited EPA’s prior refrigerant management rule under section 608 as overstepping the Agency’s authority to impose the venting prohibition on actions taken over the course of maintaining, servicing, repairing, or disposing of equipment. The commenter further stated that the AIM Act does not give the Agency the authority to regulate facility owners or compel them to install leak detection systems to be used in normal operation of equipment.

Response: With regards to one commenter’s assertions that the AIM Act did not give EPA the authority to require facilities to install leak detection systems that would be used in normal operations or authority to regulate owners or operators, the Agency disagrees with the commenter’s claims. As discussed throughout this notice, subsection (h)(1) directs EPA to promulgate regulations to control, where appropriate, any practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment, for purposes including maximizing reclamation and minimizing the release of HFCs from equipment. As explained elsewhere in this notice, EPA interprets this language to encompass practices, processes, and activities that occur before, during, and after servicing, repair, disposal, or installation of equipment. EPA understands this provision to authorize both the leak repair provisions described in section IV.C and the required use of ALD as described in IV.D because the requirements govern practices, processes, or activities regarding the servicing, repair, disposal, or installation of equipment. Determining that equipment is leaking is a critical first step in understanding that it needs servicing or repair, or perhaps to be disposed of and replaced, depending on whether or not the leak can be repaired. The ALD equipment that must be installed and operated under this requirement will inform equipment owners and operators when the equipment is leaking, and EPA expects that this knowledge will lead to earlier repairs, which in turn will prevent releases of HFCs (and potentially costly refrigerant losses). Thus, installing and operating an ALD system is a "process, practice or activity regarding servicing, repair, disposal, or installation of equipment" because taking these steps will alert the equipment owner or operator when servicing or repair of equipment may be required. Accordingly, there is a direct connection between installing and operating the ALD system and servicing or repair (or in some cases, disposal) of equipment.

EPA agrees with the comment that subsection (h) conveys authority to regulate technicians' activities during servicing and repair, but contrary to the commenter's view, nothing in the text of subsection (h) suggests that EPA is precluded from also regulating activities during normal operations that are within the scope of subsection (h) or from regulating equipment owner or operators. Moreover, imposing such restrictions could limit EPA's ability to ensure that the regulations under subsection (h) achieve the stated purposes in the statute because activities that occur during normal operations, or that are taken by equipment owners or operators, will affect efforts to maximize reclamation, minimize releases[168] from equipment, and ensure the safety of technicians and consumers. Further, the statutory phrase for what EPA regulations under (h)(1) may control — "any process, practice or activity *regarding* servicing, repair, disposal, or installation of equipment" (emphasis added)—indicates that Congress did not limit EPA to only regulate processes, practices or activities *during* servicing, repair, disposal, or installation of equipment. Indeed, the authority to regulate to "control … activities regarding servicing" includes authority to require that servicing be done, including to address refrigerant losses that occur during normal operation of equipment. Further EPA notes that it considers servicing to include a range of activities involved in preserving equipment in the normal working order, as some form of ongoing and routine servicing is necessary for proper functioning of equipment.

To the extent these comments relate to EPA's regulations under CAA section 608 they are outside the scope of this rulemaking as the Agency did not reopen the section 608 rules as part of this rulemaking and thus require no further response.[169] However, aspects of this rule are analogous to similar EPA rules under CAA section 608, which apply to owners and operators. For example, in the preamble to the 1993 CAA 608 final rule, EPA explained that it had made "additions to the scope section to clarify that the rule covers refrigerant reclaimers, *appliance owners,* and manufacturers of appliances and recycling and recovery equipment in addition to

[168] The Agency recognizes that refrigerant-containing appliances may lose refrigerant charge over time. However, manufacturers of refrigerant-containing equipment have made great strides in manufacturing equipment less prone to leaks. Nevertheless, refrigerant-containing equipment, especially with larger charge sizes, could leak significant amounts of refrigerant before a leak is detected.

[169] EPA further notes that this comment states that it incorporates by reference prior comments submitted on prior proposed rules under CAA section 608. EPA notes that in order to merit a response, comments on a proposed rule must be stated with specificity, so that the Agency can identify the commenter's concern or requested alteration to the rule at issue. A commenter's statement, such as the statement in this comment, that they are incorporating prior comments or arguments, without any further explanation of how those prior comments or arguments relate to the proposed rule or how the Agency should change its proposal, do not require a response.

persons servicing, repairing, maintaining, and disposing of appliances." 58 FR 28707 (emphasis added); *see also* 58 FR 28681. EPA explained that the rule required the owner of the equipment to either authorize the repair of substantial leaks or develop the equipment retirement/retrofit plan within 30 days of discovering a leak above the standard and that the owner has the legal obligation to ensure that repairs are made to equipment where the leak rate exceeds the standard. *See* 81 FR 82272. For similar reasons as under section 608, including the role of the equipment owner and operator in determining whether to authorize repair of a leak or whether to retire or retrofit the equipment, this final rule finds it reasonable to include the owners and operators among the regulated entities, consistent with the Agency's practice under the CAA Title VI. EPA has found this approach to be workable, and using the same approach in this final rule should be familiar to entities that have experience implementing the CAA 608 rules, reduce confusion, and facilitate compliance. For this reason, and also given the role of equipment owners and operators in making decisions about the servicing, repair, disposal, and installation of equipment, EPA concludes that it is appropriate to structure the regulations so that equipment owners and operators may be held responsible for certain violations, even if the actions of a technician may play a role in the violation, rather than adopt the commenter's view, which could improperly shield owners and operators from liability even if a decision or action they took resulted in or contributed to the violation. Further, EPA notes that while certain aspects of its experience in implementing certain requirements under CAA section 608 inform this rulemaking and while there are certain analogies between this rule and requirements established under CAA section 608, it has also been clear that AIM subsection (h) and CAA section 608 are separate and distinct statutory authorities, and that this rule is established under AIM subsection (h), such that the text and purposes of that provision govern this action. While there are some similarities in statutory text between AIM subsection (h) and CAA section 608, there are also meaningful differences to consider. Thus, to the extent that commenters suggest that a limitation they perceive in CAA section 608 would also somehow simply apply to EPA's authority under the AIM Act, without further evaluation of the relevant provisions of the AIM Act, EPA disagrees.

EPA disagrees with commenters' assertions that it does not have authority under subsection (h) of the AIM Act to regulate the loss of refrigerant during normal operations or to regulate or penalize facility owners or equipment operators, including imposing penalties on them for violations of requirements under the AIM Act. Under subsection (h), for purposes including maximizing reclaiming and minimizing the release of a regulated substance from equipment, Congress directed the Administrator to promulgate regulations to control practices, processes, or activities regarding the servicing, repair, disposal, or installation of equipment that involves a regulated substance and the reclaiming of a regulated substance used as a refrigerant. As explained in prior sections of this document, establishes regulations that apply to HFCs and or a substitute for an HFC with a GWP greater than 53 to control practices, processes, or activities regarding servicing, repair, disposal, or installation of equipment. Accordingly, the requirements established under this rule are within the scope of EPA's authority under subsection (h). For example, as explained in section IV.C.3 in this notice, EPA is establishing leak repair requirements that control practices, processes, or activities regarding servicing or repair of appliances and that provide persons engaged in such activities with additional clarity and certainty on how to ensure that their actions comport with the requirements established in this action. While many of these requirements regulate the activities of the person working on equipment, *e.g.*, those performing the leak repair, Congress did not limit EPA's authority under (h)(1) to only regulating activities that are performed directly on equipment or only those persons or entities who are directly working on equipment, but rather, as noted previously, authorized EPA to regulate a broader scope of processes, practices or activities *regarding* servicing, repair, disposal, or installation of equipment. EPA interprets the direction under subsection (h)(1) to include authority to regulate equipment owners and operators, as they make decisions and have control over processes, practices or activities regarding servicing, repair, disposal, or installation of equipment, and their decisions and actions will affect efforts to maximize reclamation, minimize releases from equipment and ensure the safety of technicians and consumers. Even if an owner or operator is not using their own personnel to service equipment, their decisions and actions could affect compliance with the requirements under this rule, such as the timing of leak repair activities and the extent to which leaks are repaired.

Further, with respect to EPA's authority to impose penalties on owners and operators, EPA responds that subsection (k)(1)(C) of the AIM Act provides that certain sections of the CAA, including section 113, apply to the AIM Act and any regulations EPA promulgates under the AIM Act as though the AIM Act were part of Title VI of the CAA. Among other things, section 113(a)(3) of the CAA, entitled "EPA enforcement of other requirements" authorizes the EPA Administrator to take certain measures if the Administrator "finds that any person has violated, or is in violation of, any … requirement or prohibition of … subchapter VI of this chapter, including, but not limited to, a requirement or prohibition of any rule … promulgated under [that] subchapter[]." Similarly, the Administrator's enforcement authorities under section 113 of the CAA also include the assessment of monetary civil penalties "against any person" if the Administrator finds that "such person" has violated or is violating any requirement or prohibition of Title VI of the CAA, "including, but not limited to, a requirement or prohibition of any rule" promulgated under Title VI. These provisions apply to the AIM Act and this rule by operation of subsection (k)(1)(C) of the AIM Act. Facility owners or operators are within the broad definition of "person" in section 302(e) of the CAA. Accordingly, EPA has authority to enforce the requirements and prohibitions of this rule against facility owners or operators, consistent with section 113 of the CAA. While, as noted previously, this action is separate and distinct from EPA's rules under CAA section 608, EPA further observes that, as described further in section IV.D above, this approach to applying regulatory requirements to owners and operators is similar to and consistent with EPA's approach to requirements in analogous rules under CAA section 608, which also include requirements that apply to owners and operators.

EPA also disagrees with commenters' assertion that EPA does not have authority under subsection (h) of the AIM Act to regulate activities during normal operations. Such restrictions could limit EPA's ability to ensure that the regulations under subsection (h) achieve the stated purposes in the statute because activities that occur during normal operations will affect efforts to maximize reclamation, minimize releases from equipment and ensure the safety of technicians and consumers. Further, the statutory phrase for what EPA regulations under (h)(1) may control--"any process, practice or activity *regarding* servicing, repair, disposal, or installation of equipment" (emphasis added)—indicates that Congress did not limit EPA to only regulate processes, practices, or activities *during* servicing, repair, disposal, or installation of equipment. Indeed, the authority to regulate to "control … activities regarding servicing [or] repair" includes authority to require that servicing or repair be done, including to address refrigerant losses that occur during normal operation of equipment. Further EPA notes that it considers servicing to include a range of activities involved in keeping equipment in the normal working order, as some form of ongoing and routine servicing is necessary for proper functioning of equipment.

EPA responds to other comments regarding leak repair in section IV.C above and regarding the use of ALD systems in section IV.D.1 above.

Comment: One commenter questioned EPA's authority to regulate sources on the Outer Continental Shelf (OCS) in the western and central Gulf of Mexico pursuant to 40 CFR part 84, and asked EPA to confirm that OCS sources in those two areas are excluded from the applicability of the proposed regulations in 40 CFR Part 84. The commenter stated that 40 CFR Part 55 delineates the EPA's air programs applicable to the OCS and that under 40 CFR 55.3(a) the scope of this part extends to all OCS sources except those west of 87.5 degrees longitude. The commenter also claimed that under the Outer Continental Shelf Lands Act (OCSLA) the Department of the Interior (DOI) has the authority to administer programs and rules relating to the OCS, including those related to air quality, and asserted that that authority is not shared with EPA, citing *California v. Kleppe*, 604 F.2d 1187, 1193 (9th Cir. 1979). The commenter further stated that section 328 of the CAA sets EPA's regulatory authority in the OCS, limiting that authority to sources east of longitude 87 degrees 30 minutes. The commenter stated that the intent of the AIM Act and the proposed rule were to regulate air quality and emissions related to HFCs and concluded that there is overlap between EPA's authority under the AIM Act and the DOI's authority. The commenter stated that EPA's proposed regulations to track, record, and provide information regarding the sale and distribution of HFCs are "similar to requirements in 43 U.S.C. [section] 1348(b)(3) for lease and permit holders to provide 'documents and records which are pertinent to . . . environmental protection, as may be requested' under OCSLA." [170] The commenter further stated that AIM Act subsection (h) provides EPA broad authority to

[170] See comment number EPA-HQ-OAR-2022-0606-0098 at 2.

promulgate regulations but that "the AIM Act is silent on the question of OCS sources and in (k)(1)(C) expressly applies sections of title VI of the CAA to EPA's authority" in the proposed regulations. The commenter further stated that the AIM Act "does not alter the existing division of jurisdiction between the EPA and DOI with regard to air quality regulations applicable to OCS sources" and that, "[a]ccordingly, … 40 CFR part 84 is not applicable to the western and central [Gulf of Mexico]," [171] and the regulation of sale and distribution of HFCs does not extend to those areas without a grant of similar authority to the DOI and the Bureau of Ocean Energy Management (BOEM) under the AIM Act. The commenter acknowledged that 40 CFR Part 84 would apply to the eastern Gulf of Mexico, given that BOEM has not been delegated authority over air quality in this specific area.

Response: EPA disagrees with the commenter's broad assertions that EPA does not have authority under the AIM Act to issue regulations pertaining to HFCs and their substitutes related to offshore operations in the western and central Gulf of Mexico. EPA also disagrees with the commenter's assertions that the regulations finalized in this action under subsection (h) of the AIM Act are not applicable in the western and central Gulf of Mexico and that OCS sources situated in the western and central Gulf of Mexico are excluded from these regulations. The commenter cites *California v. Kleppe*, 604 F.2d 1187, 1193-94 (9th Cir. 1979) ("*Kleppe*") for the proposition that DOI has "sole" authority to promulgate air quality regulations for OCS sources, which is not shared with EPA. But *Kleppe* addresses DOI's authorities over offshore activities as those authorities existed in 1979, long before both the 1990 Amendments to the CAA, which authorized EPA to regulate air emissions from OCS sources (42 U.S.C. § 7627, Pub. L. 101-549,

[171] See comment number EPA-HQ-OAR-2022-0606-0098 at 2-3.

Title VIII, Sec. 801 ("OCS air pollution"), November 15, 1990), and Congress's 2020 enactment of the AIM Act, which authorized EPA to promulgate regulations to address HFCs (42 U.S.C. § 7675, Pub. L. 116–260, Division S, Sec. 103 ("American Innovation and Manufacturing"), December 27, 2020). *Kleppe* therefore does not speak to EPA's current authorities under either the CAA or the AIM Act. Additionally, while the commenter states that aspects of this rule are "similar to" DOI's authorities to seek records and documents under OCSLA, it fails to identify any conflict between these requirements or to provide any other support for a conclusion that the relevant provisions cannot all be given effect.

This rule implements Congress's direction in subsection (h)(1) of the AIM Act for EPA to establish regulations "to control, where appropriate, any practice, process or activity regarding the servicing, repair, disposal, or installation of equipment" that involves an HFC or a substitute for an HFC, or the reclaiming of an HFC or a substitute for an HFC used as a refrigerant, for purposes of maximizing reclamation, minimizing releases of HFCs from equipment, and ensuring the safety of technicians and consumers. The AIM Act, which was enacted separately from the CAA, does not exclude any geographic area within the United States from the scope of EPA's authorities under in the Act. In fact, certain provisions of the Act clearly indicate that the Act applies throughout the United States. For example, subsection (b)(6) of the AIM Act defines the term "import" to mean "to land on, bring into, or introduce into, or attempt to to land on, bring into, or introduce into, any place subject to the jurisdiction of the United States."

The commenters cite certain geographic restrictions on EPA's authority to regulate air pollution from OCS sources under CAA section 328 and EPA's implementing regulations in 40 CFR Part 55, suggesting that EPA's regulatory authority over emissions sources in the Gulf of Mexico is limited to "sources east of longitude 87 degrees 30 minutes" (or 87.5 degrees longitude) under these statutory and regulatory provisions. Section 328 of the CAA, however, pertains only to EPA's authorities under the CAA with respect to "OCS sources" and has no bearing on EPA's independent authorities under the AIM Act and other federal statutes. In addition to the AIM Act, which, by its terms, applies to activities such as production and consumption of HFCs, restrictions on use of HFCs in the sectors or subsectors in which they are used, and practices, processes, or activities regarding servicing, repair, disposal, or installation of equipment that involves an HFC or a substitute for an HFC, or the reclaiming of an HFC or a substitute for an HFC used as a refrigerant, the Deepwater Port Act directs that federal laws apply to deepwater ports "and to activities connected, associated, or potentially interfering with the use or operation of any such port, in the same manner as if such port were an area of exclusive Federal jurisdiction located within a State…." 33 U.S.C. § 1518(a)(1). Thus, any deepwater port or associated activity that would be subject to the AIM Act if located onshore remains subject to these requirements offshore, both in the Gulf of Mexico and in other waters over the OCS. The requirements of the AIM Act, the Deepwater Port Act, and other federal laws apply by their terms to sources located offshore, independent of the authorities and limitations specified in CAA section 328 with respect to OCS sources.

The commenter's reference to section (k)(1)(C) of the AIM Act provides no support for a claim that EPA's authorities under the AIM Act are limited by CAA section 328. Section (k)(1)(C) of the AIM Act states that "sections 113, 114, 304, and 307 of the Clean Air Act (42 U.S.C. 7413, 7414, 7604, 7607) shall apply" to the AIM Act and any regulations EPA promulgates under the AIM Act as though the AIM Act were part of Title VI of the CAA. These provisions of the CAA pertain to federal and citizen enforcement, EPA's information-gathering authorities, and judicial review of EPA's actions under the CAA. By directing that these provisions apply to the AIM Act and any implementing regulations promulgated by EPA to implement the AIM Act, Congress provided EPA and citizens with the same enforcement and information-gathering authorities that the CAA provides and vested the United States Courts of Appeals with jurisdiction to review challenges to EPA's final actions under the AIM Act, in the same manner as under the CAA. CAA section 328 (42 U.S.C. 7627), by contrast, authorizes EPA to "establish requirements to control air pollution from Outer Continental Shelf sources" in specific offshore areas. Section 328 is not included among the CAA provisions expressly identified in section (k)(1)(C) of the AIM Act, and there is no indication in either the CAA or the AIM Act that Congress intended for EPA's regulatory authorities with respect to OCS sources under CAA section 328 to apply to or limit its authorities with respect to HFCs or HFC substitutes under the AIM Act.

The AIM Act itself creates no exemption for emissions sources in the western and central Gulf of Mexico from its requirements. Establishing an exemption from the requirements of this rule for sources in the western and central Gulf of Mexico could create an unequal framework rather than fairly applying regulations under the AIM Act subsection (h) to similarly situated sources, including those in the eastern Gulf of Mexico, which the commenter concedes would be subject to these rules.

EPA further notes that this ER&R rule implements provisions under subsection (h) of the AIM Act. To the extent this comment relates to the application of EPA's rules under CAA Title VI or other particular aspects of the AIM Act or regulations under Part 84, those topics are beyond the scope of this rulemaking and thus require no further response.

Regarding the commenter's statement about the tracking, recordkeeping, and reporting of information regarding sale and distribution of HFCs, as noted previously in this preamble, EPA is not finalizing the proposed provisions for container tracking of HFCs that could be used in the servicing, repair, and/or installation of refrigerant-containing or fire suppression equipment. Thus, any concerns pertaining to that aspect of the proposal are not relevant to this action. However, EPA is establishing a discrete reporting requirement to better understand the use of reclaimed HFCs in the subsectors covered in this rulemaking, as described in section IV.E.2 above. EPA additionally notes that the other recordkeeping and reporting provisions established under this rule provide no exemption for offshore sources, and remain applicable by their terms, consistent with the discussion earlier in this response to comment."

Comment: One commenter stated that EPA's statutory authority and specific legislative guidance indicated the importance of interpreting similar authorities to avoid unreasonable outcomes and thus understood subsection (h)(2) to mean that in developing regulations for equipment servicing, repair, disposal, or installation "EPA should prioritize, and may only have the authority to prioritize, the exploration of opportunities for refrigerant reclamation." The commenter argued that this interpretation aligns with the Agency's mission and ensures a responsible and sustainable approach to refrigerant management, while ensuring that there is adequate access to refrigerant supply to meet demand.

Response: EPA disagrees with the commenter's interpretation of subsection (h)(2). Subsection (h)(1) of the AIM Act provides EPA authority to promulgate regulations to control, where appropriate, any practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment that involves HFCs or their substitutes, or the reclaiming of HFCs or their substitutes used as refrigerants. Subsection (h)(2)(A) of the Act provides that the Administrator "shall consider the use of authority available … under this section to increase opportunities for the reclaiming of regulated substances used as refrigerants." Subsection (h)(2)(B) of the Act provides that a "regulated substance used as a refrigerant that is recovered shall be reclaimed before the regulated substance is sold or transferred to a new owner, except where the recovered regulated substance is sold or transferred to a new owner solely for the purposes of being reclaimed or destroyed." While subsection (h)(2)(A) requires that the Agency consider the potential to increase opportunities for reclamation of regulated substances used as refrigerants, nothing in this statutory language limits the use of EPA's authorities for other purposes or requires that the Agency reach a certain result based on such consideration. Nothing in the text of either subsection (h)(2)(A) or (B) suggests that it is intended to modify the grant of regulatory authority in subsection (h)(1) or dictate the Agency's priorities in implementing subsection (h)(1). Further, such an interpretation of subsection (h)(2) could unduly restrict EPA's ability to fully implement the regulatory authority granted in subsection (h)(1), for example in promulgating regulations consistent with that provision that are focused on the purposes identified in subsection (h)(1) of minimizing releases of HFCs from equipment and ensuring the safety of technicians and consumers. Notwithstanding EPA's disagreement with the commenters' interpretation of (h)(2), the Agency notes it has considered various uses of its authority in this rulemaking that could increase opportunities for reclamation of HFCs used as refrigerants and that several aspects of this final rule that are focused on maximizing reclamation of HFCs could also increase opportunities for reclamation.

Comment: Many commenters expressed support for the development of new requirements for technician training and certification. Some commenters also expressed support for continuing education requirements, recertification requirements, and developing new requirements for already certified technicians. Other commenters expressed support for new requirements for technicians obtaining certifications for the first time but opposed requirements for already certified technicians. Some commenters stated that requirements for technician training and certification would ensure that technicians are up to date relative to changes in the industry, are properly trained for the installation and servicing of equipment, can handle flammability and safety concerns such as those associated with new refrigerants, and are aware of regulatory requirements related to HFCs such as the prohibition on venting. Some commenters also stated that technician and certification requirements would encourage recovery and reclamation, protect facility owners and operators, reduce emissions, ensure a smooth transition, promote adoption of new refrigerants, change the culture in the industry to reinforce the use of proper methods, and enhance compliance. Some commenters mentioned that current requirements are inadequate to ensure that HFCs are managed correctly.

Other commenters expressed opposition to the development of new requirements for technician training and certification. Some commenters stated that such requirements would add compliance burdens without environmental and safety benefits, that such requirements would exceed EPA's authority, that technicians do not want to be forced to take a test, that certain entities would profit off of the certification requirements, that requirements would impose added costs on technicians, that requirements would dissuade potential HVAC professionals from entering the industry, that existing government and industry requirements are sufficient, and that already certified technicians should not be subject to new requirements. One commenter suggested that EPA encourage but not mandate training and certification, and another commenter expressed openness to more training but opposed any more EPA requirements.

Response: EPA acknowledges these comments. As discussed in section I.B above in this action, EPA also issued in conjunction with the proposed rule an ANPRM seeking information on approaches for establishing requirements for technician training and/or certification. EPA explained in that notice that it was not proposing and will not be finalizing a technician training and certifying program on which it sought advance comment. Accordingly, EPA explained that the Agency did not intend to respond to any advance information received. However, EPA intends to consider those comments as part of a potential future notice and comment rulemaking to establish a training and/or certification program. Therefore, EPA is not addressing technician training in this final rulemaking and accordingly is not responding to comments on the ANPRM in this action. However, EPA is establishing requirements for fire suppression technician training, as described in section IV.F.2.d.

Comment: One commenter argued that EPA must take additional steps, on its own and in conjunction with other federal agencies, to level the playing field for reclaimers. For example, the commenter stated that EPA should revise its implementation of the SNAP program to curtail patent or contractual limitations on reclamation. Among other comments related to the Allocation Program, the commenter argued that EPA should use administrative consequences in additional scenarios including to entities engaged in market manipulation, patent misconduct, and "unfair trade practices" and that all allowances revoked pursuant to administrative consequences should be reallocated to EPA-certified reclaimers. Additionally, the commenter stated that EPA should change the provision in the Framework Allocation Rule allowing HFCs contained in equipment to be imported without expending allowances. The commenter further stated that EPA should assign a GWP value of zero to all refrigerants reclaimed in the U.S. by EPA-certified reclaimers, establish a "life-cycle adjusted GWP" value for all refrigerants to reflect their actual reclaim rate, and use that adjusted GWP value for purposes of all AIM Act regulatory programs, as well as establish a recycle or release rate for every SNAP-approved product. The commenter also argued that EPA should develop a rule providing that refrigerants that do not meet a 15% reclaim rate could be designated as unacceptable substitutes under SNAP.

The commenter further argued that EPA should require all recovered refrigerant to be exclusively returned to EPA-certified reclaimers and should update the certification requirements for reclaimers. The commenter also stated that EPA should establish a mechanism for reclaimers or third parties to seek EPA intervention to prevent or call attention to anticompetitive practices that harm the reclaim market. The commenter further argued that EPA should create a unified reporting portal for EPA-certified reclaimers. The commenter argued that EPA should enhance its engagement with DOC and U.S. Customs and Border Protection to address anticompetitive behavior by virgin refrigerant producers and ensure a level playing field, especially regarding antidumping and countervailing duties and the 2016 Blends Order. Finally, the commenter suggested that state and local government agencies and regulatory bodies consider imposing fees on all newly manufactured HFC/HFO refrigerant products and stated that EPA should support this effort.

Response: Regarding the commenter's points on patent or contractual limitations on reclamation, providing mechanisms for reclaimers related to anticompetitive practices, implementation of the SNAP program, and requested listings as unacceptable under EPA's SNAP program, these comments are outside the scope of this final rule promulgated under the AIM Act and thus require no further response. The commenter's suggestions for changes to the administrative consequences under the Allocation Program as well as the requested changes to the regulations established by the Framework Allocation Rule and codified at 40 CFR part 84, subpart A are also outside the scope of this final rule and thus require no further response. Regarding commenter's points regarding assigned GWP values, EPA responds that subsection

(c) of the AIM Act assigns exchange values for regulated substances that are based on the GWP values listed in IPCC AR4, which are codified in EPA's regulations as appendix A to 40 CFR part 84, and that this rulemaking did not propose, and is not finalizing, new or revised GWP values for any regulated substances. By their terms, the exchange values listed in subsection (c) of the AIM Act and codified at appendix A to 40 CFR part 84 apply to regulated substances regardless of whether the substance is newly manufactured or reclaimed, and they are based on physical properties of the compound itself that are the same for a substance, regardless of whether it is virgin or reclaimed. Further, to the extent that commenters on this rule are using terminology that is used under the Allowance Allocation Program in ways that diverge from how the Agency uses those terms or seeking modifications to requirements under that program, EPA is not making any changes to the Allowance Allocation Program in this rule. Under the regulations at 40 CFR 84.5(b)(1) the quantity of consumption allowances that must be expended for an import of a regulated substance must be equal to the exchange-value weighted equivalent of the regulated substances imported. EPA is not changing that requirement for any regulated substance in this rulemaking.

Regarding comments recommending that EPA require all recovered refrigerant to be exclusively returned to EPA-certified reclaimers, EPA is requiring that heels from disposable cylinders that were used in the servicing, repair, or installation of refrigerant containing equipment or fire suppression equipment be sent to a reclaimer, fire suppression recycler, final processor, or refrigerant supplier. Further, as discussed in section IV.E.1 above, EPA is also establishing labeling and recordkeeping requirements, as proposed, and prohibiting the sale, identification, or reporting of refrigerant as being reclaimed if the HFC component of the resulting refrigerant contains more than 15 percent, by weight, of virgin HFC. EPA proposed and is requiring that certified reclaimers affix this label to reclaimed HFCs being sold or distributed or offered for sale or distribution beginning January 1, 2026.

IX. Judicial Review

The AIM Act regulations promulgated herein may be challenged in the United States Court of Appeals for the District of Columbia Circuit. Pursuant to section 307(b)(1) of the CAA, petitions for judicial review of the AIM Act regulations must be filed in that court within 60 days after the date notice of this final action is published in the **Federal Register**. Any person seeking to challenge both the AIM Act regulations and the RCRA regulations must file the challenge to the AIM Act regulations within 60 days after the date notice of this final action is published in the **Federal Register**.

The AIM Act provides that certain sections of the CAA "shall apply to" the AIM Act and to "any rule, rulemaking, or regulation promulgated by the Administrator of [EPA] pursuant to [the AIM Act] as though [the AIM Act] were expressly included in title VI of [the CAA]." 42 U.S.C. 7675(k)(1)(C). Among the applicable sections of the CAA is section 307, which includes provisions on judicial review. Section 307(b)(1) provides, in part, that petitions for review must be filed in the United States Court of Appeals for the District of Columbia Circuit: (i) When the Agency action consists of "nationally applicable regulations promulgated, or final action taken, by the Administrator," or (ii) when such action is locally or regionally applicable, but such action is "based on a determination of nationwide scope or effect."

The AIM Act regulations promulgated herein are "nationally applicable regulations" within the meaning of CAA section 307(b)(1). These regulations define and interpret terms under the AIM Act and establish regulatory requirements applicable across the entire United States to implement subsection (h) of the AIM Act, including requirements to control practices, processes, or activities regarding the servicing, repair, disposal, or installation of equipment that involves: a regulated substance, a substitute for a regulated substance, the reclaiming of a regulated substance used as a refrigerant, or the reclaiming of a substitute for a regulated substance used as a refrigerant, as well as regulatory requirements for labeling, recordkeeping, and reporting, for purposes including maximizing reclamation and minimizing releases of regulated substances from equipment. Accordingly, under section 307(b)(1) of the CAA, petitions for judicial review of these AIM Act regulations must be filed in the United States Court of Appeals for the District of Columbia by [**INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER**].

EPA's RCRA regulations promulgated herein may be challenged in the United States Court of Appeals for the District of Columbia Circuit. Section 7006(a)(1) of RCRA provides that "a petition for review of action of the Administrator in promulgating any regulation, or requirement under this chapter … may be filed only in the United States Court of Appeals for the District of Columbia, and such petition shall be filed within ninety days from the date of such promulgation …." Accordingly, petitions for judicial review of the RCRA regulations promulgated herein must be filed in the United States Court of Appeals for the District of Columbia by [**INSERT DATE 90 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER**]. Any person seeking to challenge both the AIM Act regulations and the RCRA regulations must file the challenge to the RCRA regulations within 90 days after the date notice of this final action is published in the **Federal Register**.

X. Severability

As noted previously, in this **Federal Register** notice we are providing notice of two sets of regulations: one under the AIM Act and another under RCRA. Accordingly, as explained in the proposal and in other sections of this notice, as well as in the following paragraphs for clarity, this notice of final rulemaking is multifaceted and addresses many separate issues for independent reasons. For example, the AIM Act regulations include definitions and interpretations of terms under the AIM Act; new requirements, including provisions that address maximizing the reclamation and minimizing the release of HFCs from equipment under subsection (h) of that Act; and labeling, recordkeeping, and reporting requirements to support the enforcement of the new provisions. EPA has separately considered and adopted the elements of the AIM Act regulations, including: leak repair of refrigerant-containing appliances; use of reclaimed HFCs for the servicing and/or repair of certain refrigerant-containing equipment; the use of recycled HFCs in fire suppression equipment; emissions reductions in the fire suppression sector; and removal of HFCs from disposable cylinders before discarding them. Each of these requirements is supported by a separate analysis and rationale, based on independent consideration of issues such as the particular processes, practices, or activities that are relevant to and controlled by the requirement and how the requirements relate to the purposes identified in subsection (h)(1). These requirements also address different sectors and subsectors (RACHP and fire suppression). EPA intends for requirements for each of these topics to be able to stand independently from one another and has designed them accordingly. For example, the leak repair requirements for refrigerant-containing appliances are designed to operate independently from the requirements for servicing, repair, disposal, or installation of fire suppression equipment, as they address different types of equipment and are each independently intended to further serve the purposes of maximizing the reclamation and minimizing the release of HFCs from equipment. Similarly, while the requirements to use reclaimed HFCs in servicing and/or repair of refrigerant-containing equipment and to use recycled HFCs in the fire suppression sector also serve those same purposes, they do so by addressing processes, practices, or activities regarding the servicing, repair, installation, or disposal of equipment that differ both from those addressed by the leak repair requirements for refrigerant containing appliance and those addressed by the emissions reductions requirements for fire suppression equipment, as well as from one another. Likewise, while the requirements for removal of HFCs from disposable cylinders also help serve the purpose of maximizing reclamation, this portion of the AIM Act regulations is not integral to the adoption of the standards for what constitutes reclaimed HFC refrigerant, requirements for use of reclaimed HFCs, or other requirements.

In this notice of final rulemaking, EPA is also amending regulations under RCRA, which are separate from the regulations under subsection (h)(1) of the AIM Act, to establish alternative standards for ignitable spent refrigerants when recycled for reuse, as the term "recycle" is to be used under RCRA. These standards are established under a different set of statutory authorities than the AIM Act regulations, and they are part of an independent and distinct regulatory regime. While we intend for the AIM Act regulations and the separate RCRA regulations described in this notice of final rulemaking to operate independently of one another and to be severable from each other, we are providing notice of both sets of regulations simultaneously because both the RCRA regulations concerning the recovery and recycling of certain ignitable spent refrigerants and the AIM Act regulations concerning recovery and reclamation of refrigerants may be of interest to some of the same stakeholders.

Thus, EPA has independently considered and adopted the RCRA regulations (including the element for the RCRA alternative standards for ignitable spent refrigerants when recycled for reuse) and the AIM Act regulations (including but not limited to the elements of the ER&R program related to leak repair of refrigerant-containing appliances; use of reclaimed HFCs for the servicing and/or repair of certain refrigerant-containing equipment; the use of recycled HFCs in fire suppression equipment; emissions reductions in the fire suppression sector; and removal of HFCs from disposable cylinders before discarding them) and these elements of these regulations are severable from the others. If a court were to invalidate any one of these elements, EPA intends the remainder of the provisions to remain effective, as the Agency has designed the elements of both the AIM Act regulations and the RCRA regulations to function sensibly and separately, and finds each portion appropriate, even if one or more other provisions has been set aside. Moreover, this discussion is not intended to be exhaustive, and should not be viewed as an intention by EPA to consider other requirements not explicitly listed here as not severable from other requirements.

XI. Statutory and Executive Order Reviews

Additional information about these statutes and Executive Orders can be found at *https://www.epa.gov/laws-regulations/laws-and-executive-orders*.

A. Executive Order 12866: Regulatory Planning and Review and Executive Order 14094: Modernizing Regulatory Review

This action is a "significant regulatory action", as defined under section 3(f)(1) of Executive Order 12866, as amended by Executive Order 14094. Accordingly, EPA submitted this action to the Office of Management and Budget (OMB) for Executive Order 12866 review. Documentation of any changes made in response to the Executive Order 12866 review is available in the docket. EPA prepared an analysis of the potential costs and benefits associated with this action. This analysis, *Final Regulatory Impact Analysis Addendum: Analysis of the Economic Impact and Benefits of the Proposed Rule: American Innovation and Manufacturing (AIM) Act Subsection H Management of Regulated Substances* (Docket Number EPA-HQ-OAR-

2022-0606), is also available in the docket and is summarized in section I.C. and section VI. of this preamble.

B. Paperwork Reduction Act (PRA)

The information collection activities in this rule have been submitted for approval to the OMB under the PRA. The ICR document that EPA prepared has been assigned EPA ICR number 2778.02. You can find a copy of the ICR in the docket for this rule, and it is briefly summarized here. The information collection requirements are not enforceable until OMB approves them.

Subsection (k)(1)(C) of the AIM Act states that section 114 of the CAA applies to the AIM Act and rules promulgated under it as if the AIM Act were included in title VI of the CAA. Thus, section 114 of the CAA, which provides authority to EPA Administrator to require recordkeeping and reporting in carrying out provisions of the CAA, also applies to and supports this rulemaking.

EPA is establishing certain labeling requirements for containers of reclaimed HFCs. EPA is also establishing recordkeeping and reporting requirements for owners or operators of applicable refrigerant-containing appliances that contain HFCs or certain substitutes for HFCs to support compliance with the leak repair provisions, as well as recordkeeping and reporting requirements for the fire suppression provisions for HFCs. Additionally, where ALD systems are required, EPA is establishing that owners or operators maintain records regarding the annual calibration or audit of the system.

Respondents/affected entities: Respondents and affected entities will be individuals or companies that own, operate, service, repair, recycle, dispose, or install equipment containing HFCs or their substitutes addressed by this final rule, as well as individuals or companies that recover, recycle, or reclaim HFCs or such substitutes.

Respondent's obligation to respond: Mandatory (AIM Act and section 114 of the CAA).

Estimated number of respondents: 781,563

Frequency of response: Quarterly, annually, and as needed depending on the nature of the report.

Total estimated burden: 222,268 hours (per year). Burden is defined at 5 CFR 1320.3(b).

Total estimated cost: $17,069,893 (per year), includes $0 annualized capital or operation & maintenance costs.

An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations in 40 CFR are listed in 40 CFR part 9. When OMB approves this ICR, the Agency will announce that approval in the FR and publish a technical amendment to 40 CFR part 9 to display the OMB control number for the approved information collection activities contained in this final rule.

C. Regulatory Flexibility Act (RFA)

I certify that this action will not have a SISNOSE under the RFA. The small entities subject to the requirements of this action include those that may use as refrigerant, use as a fire suppression agent, reclaim, or recycle HFCs. EPA estimates that approximately 493 of the 767,568 potentially affected small entities could incur costs in excess of one percent of annual sales/revenue and that approximately 12 small entities could incur costs in excess of three percent of annual sales/revenue. Because there is not a substantial number of small entities that may experience a significant impact, it can be presumed that this action will have no SISNOSE.

Details of this analysis are presented in Economic Impact and Benefits TSD. (Docket ID EPA–HQ–OAR–2022-0606).

D. Unfunded Mandates Reform Act (UMRA)

This action does not contain an unfunded mandate of $100 million or more as described in UMRA, 2 U.S.C. 1531–1538, and does not significantly or uniquely affect small governments.

E. Executive Order 13132: Federalism

This action does not have federalism implications. It will not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government.

F. Executive Order 13175: Consultation and Coordination with Indian Tribal Governments

This action does not have Tribal implications as specified in Executive Order 13175. It will not have substantial direct effects on Tribal governments, on the relationship between the Federal government and Indian Tribes, or on the distribution of power and responsibilities between the Federal government and Indian Tribes, as specified in Executive Order 13175. Thus, Executive Order 13175 does not apply to this action. EPA periodically updates Tribal officials on air regulations through the monthly meetings of the National Tribal Air Association and will share information on this rulemaking through this and other fora.

G. Executive Order 13045: Protection of Children from Environmental Health and Safety Risks

Executive Order 13045 directs federal agencies to include an evaluation of the health and safety effects of the planned regulation on children in federal health and safety standards and explain why the regulation is preferable to potentially effective and reasonably feasible alternatives. This action is subject to Executive Order 13045 because it is a significant regulatory action under section 3(f)(1) of Executive Order 12866, and EPA believes that the environmental health or safety risk addressed by this action has a disproportionate effect on children. Accordingly, we have evaluated the environmental health or safety effects of climate change on children.

GHGs, including HFCs, contribute to climate change. Certain populations and life stages, including children, the elderly, and the poor, are most vulnerable to climate-related health effects. The results of this evaluation are contained in the assessment literature cited in EPA's 2009 and 2016 Endangerment Findings. The assessment literature since 2016 strengthens these conclusions by providing more detailed findings regarding these groups' vulnerabilities and the projected impacts they may experience.

This action is preferred over other regulatory options analyzed because the GHG emissions reductions resulting from implementation of this rule will further reduce risks to children's health associated with the avoided emissions. These assessments describe how children's unique physiological and developmental factors contribute to making them particularly vulnerable to climate change. Impacts to children are expected from heat waves, air pollution, infectious and waterborne illnesses, and mental health effects resulting from extreme weather events. In addition, children are among those especially susceptible to most allergic diseases, as well as health effects associated with heat waves, storms, and floods. Additional health concerns may arise in low-income households, especially those with children, if climate change reduces food availability and increases prices, leading to food insecurity within households.

More detailed information on the impacts of climate change to human health and welfare is provided in section III.B. of this preamble.

H. Executive Order 13211: Actions that Significantly Affect Energy Supply, Distribution, or Use

This action is not a "significant energy action" because it is not likely to have a significant adverse effect on the supply, distribution or use of energy. This action applies to certain regulated substances and certain equipment containing regulated substances or certain substitutes for regulated substances, none of which are used to supply or distribute energy.

I. National Technology Transfer and Advancement Act (NTTAA)

This rulemaking does not involve technical standards.

J. Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations and Executive Order 14096: Revitalizing our Nation's Commitment to Environmental Justice for All

EPA believes that the human health or environmental conditions that exist prior to this action result in or have the potential to result in disproportionate and adverse human health or environmental effects on communities with environmental justice concerns. EPA carefully evaluated available information on HFC reclamation facilities and the characteristics of nearby communities to evaluate these impacts in the context of this final rulemaking. Based on this analysis, EPA finds evidence of environmental justice concerns near HFC reclamation facilities from cumulative exposure to existing environmental hazards in these communities.

The analysis shows that communities near the 24 identified HFC reclamation facilities are generally more diverse than the national average with respect to race and ethnicity. While the median income of these communities is slightly higher than the national average, there are more low-income households. Across the nineteen facilities, total respiratory risk and total cancer risk are lowest for the communities nearest the reclamation sites. While the cancer risk within 1-mile of the facilities is lower than the national average, the cancer and respiratory risks are otherwise slightly elevated compared to the average.

This rule is expected to result in benefits in the form of reduced GHG emissions. The analysis conducted for this rule also estimates that a portion of these benefits would be incremental to emissions reductions that were anticipated under the Allocation Framework Rule alone, thus further reducing the risks of climate change associated with those emissions.

EPA believes that it is not practicable to assess whether this action is likely to result in new disproportionate and adverse effects on communities with environmental justice concerns. While providing additional overall climate benefits, this rule may also result in changes in emissions of air pollutants or other chemicals which are potential byproducts of HFC reclamation processes at affected facilities. The market for reclaimed HFCs could drive changes in potential risk for communities living near these facilities due to the changes in emissions that could have local effects is uncertain. However, the nature and location of the emission changes are uncertain. Moreover, there is insufficient information at this time about which facilities will change reclamation processes. Given limited information at this time, it is unclear to what extent this rule will impact existing disproportionate adverse effects on communities living near HFC reclamation facilities. The Agency will continue to evaluate the impacts of this rulemaking on communities with environmental justice concerns and consider further action, as appropriate, to protect health in communities affected by HFC reclamation. The information supporting this Executive Order review is contained in section VII of this preamble.

K. Congressional Review Act (CRA)

This action is subject to the CRA, and EPA will submit a rule report to each House of the Congress and to the Comptroller General of the United States. This action meets the criteria set forth in 5 U.S.C. 804(2).

List of Subjects

40 CFR Part 84

Environmental protection, Administrative practice and procedure, Air pollution control, Chemicals, Climate change, Emissions, Reclaiming, Recycling, Reporting and recordkeeping requirements.

40 CFR Part 261

Environmental protection, Hazardous waste, Recycling, Reporting and recordkeeping requirements.

40 CFR Part 262

Environmental protection, Exports, Hazardous materials transportation, Hazardous waste, Imports, Labeling, Packaging and containers, Reporting and recordkeeping requirements.

40 CFR Part 266

Environmental protection, Energy, Hazardous waste, Recycling, Reporting and recordkeeping requirements.

40 CFR Part 270

Environmental protection, Administrative practice and procedure, Confidential business information (CBI), Hazardous materials transportation, Hazardous waste, Reporting and recordkeeping requirements, Water pollution control, Water supply.

40 CFR Part 271

Environmental protection, Administrative practice and procedure, Confidential business information, Hazardous materials transportation, Hazardous waste, Indians—lands, Intergovernmental relations, Penalties, Reporting and recordkeeping requirements, Water pollution control, Water supply.

Michael S. Regan,

Administrator.

For the reasons stated in the preamble, EPA amends 40 CFR parts 84, 261, 262, 266, 270, and 271 as follows:

PART 84—PHASEDOWN OF HYDROFLUOROCARBONS

1. The authority citation for part 84 continues to read as follows:

Authority: Pub. L. 116-260, Division S, Sec. 103.

2. Add subpart C, consisting of §§ 84.100 through 84.120, to read as follows:

Subpart C—Management of Regulated Substances

§ 84.100 Purpose.

The purpose of the regulations in this subpart is to implement subsection (h) of 42 U.S.C. 7675, with respect to controls for any practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment, for purposes of maximizing reclaiming, minimizing the release of regulated substances from equipment, and ensuring the safety of technicians and consumers.

§ 84.102 Definitions.

For the terms not defined in this subpart but that are defined in § 84.3, the definitions in § 84.3 shall apply. For the purposes of this subpart C:

Certified technician means a technician that has been certified per the provisions at 40 CFR 82.161.

Comfort cooling means the refrigerant-containing appliances used for air conditioning to provide cooling in order to control heat and/or humidity in occupied facilities including but not limited to residential, office, and commercial buildings. Comfort cooling appliances include but are not limited to chillers, commercial split systems, dual-function heat pumps, and packaged roof-top units.

Commercial refrigeration means the refrigerant-containing appliances used in the retail food and cold storage warehouse subsectors. Retail food appliances include the refrigerant-containing equipment found in supermarkets, convenience stores, restaurants, and other food service establishments. Cold storage includes the refrigerant-containing equipment used to store meat, produce, dairy products, and other perishable goods.

Component, as it relates to a refrigerant-containing appliance, means a part of the refrigerant circuit within an appliance including, but not limited to, compressors, condensers, evaporators, receivers, and all of its connections and subassemblies.

Custom-built means that the industrial process refrigeration equipment or any of its components cannot be purchased and/or installed without being uniquely designed, fabricated and/or assembled to satisfy a specific set of industrial process conditions.

Disposal, as it relates to refrigerant-containing equipment, means the process leading to and including:

(1) The discharge, deposit, dumping, or placing of any discarded refrigerant-containing equipment into or on any land or water;

(2) The disassembly of any refrigerant-containing equipment for discharge, deposit, dumping, or placing of its discarded component parts into or on any land or water;

(3) The vandalism of any refrigerant-containing equipment such that the refrigerant is released into the environment or would be released into the environment if it had not been recovered prior to the destructive activity;

(4) The disassembly of any refrigerant-containing equipment for reuse of its component parts; or

(5) The recycling of any refrigerant-containing equipment for scrap.

Disposal, as it relates to fire suppression equipment, means the process leading to and including:

(1) The discharge, deposit, dumping, or placing of any fire suppression equipment into or on any land or water;

(2) The disassembly of any fire suppression equipment for discharge, deposit, or dumping, or placing of its discarded component parts into or on any land or water; or

(3) The disassembly of any fire suppression equipment for reuse of its component parts.

Equipment means any device that contains, uses, detects, or is otherwise connected or associated with a regulated substance or substitute for a regulated substance, including any component, system, refrigerant-containing appliance, and fire suppression equipment.

Fire suppression equipment means any device that is connected to or associated with a regulated substance or substitute for a regulated substance, including blends and mixtures, consisting in part or whole of a regulated substance or a substitute for a regulated substance, and that is used for fire suppression purposes. This term includes any such equipment, component, or system. This term does not include military equipment used in deployable and expeditionary situations. This term also does not include space vehicles as defined in 40 CFR 84.3.

Fire suppression technician means any person who in the course of servicing, repair, disposal, or installation of fire suppression equipment could be reasonably expected to violate the integrity of the fire suppression equipment and therefore release fire suppressants into the environment.

Follow-up verification test, as it relates to a refrigerant-containing appliance, means those tests that involve checking the repairs to an appliance after a successful initial verification test and after the appliance has returned to normal operating characteristics and conditions to verify that the repairs were successful. Potential methods for follow-up verification tests include, but are not limited to, the use of soap bubbles as appropriate, electronic or ultrasonic leak detectors, pressure or vacuum tests, fluorescent dye and black light, infrared or near infrared tests, and handheld gas detection devices.

Full charge, as it relates to a refrigerant-containing appliance, means the amount of refrigerant required for normal operating characteristics and conditions of the appliance as determined by using one or a combination of the following four methods:

(1) Use of the equipment manufacturer's determination of the full charge;

(2) Use of appropriate calculations based on component sizes, density of refrigerant, volume of piping, and other relevant considerations;

(3) Use of actual measurements of the amount of refrigerant added to or evacuated from the appliance, including for seasonal variances; and/or

(4) Use of an established range based on the best available data regarding the normal operating characteristics and conditions for the appliance, where the midpoint of the range will serve as the full charge.

Industrial process refrigeration means complex customized refrigerant-containing appliances that are directly linked to the processes used in, for example, the chemical, pharmaceutical, petrochemical, and manufacturing industries. This sector also includes industrial ice machines, appliances used directly in the generation of electricity, and ice rinks. Where one appliance is used for both industrial process refrigeration and other applications, it will be considered industrial process refrigeration equipment if 50 percent or more of its operating capacity is used for industrial process refrigeration.

Initial verification test, as it relates to a refrigerant-containing appliance, means those leak tests that are conducted after the repair is finished to verify that a leak or leaks have been repaired before refrigerant is added back to the appliance.

Installation means the process of setting up equipment for use, which may include steps such as completing the refrigerant circuit, including charging equipment with a regulated substance or substitute for a regulated substance, or connecting cylinders containing a regulated substance or a substitute for a regulated substance to a total flooding fire suppression system, such that the equipment can function and is ready for use for its intended purpose.

Leak inspection, as it relates to a refrigerant-containing appliance, means the examination of an appliance to detect and determine the location of refrigerant leaks. Potential methods include, but are not limited to, ultrasonic tests, gas-imaging cameras, bubble tests as appropriate, or the use of a leak detection device operated and maintained according to manufacturer guidelines. Methods that determine whether the appliance is leaking refrigerant but not the location of a leak, such as standing pressure/vacuum decay tests, sight glass checks, viewing receiver levels, pressure checks, and charging charts, must be used in conjunction with methods that can determine the location of a leak.

Leak rate, as it relates to a refrigerant-containing appliance, means the rate at which an appliance is losing refrigerant, measured between refrigerant charges. The leak rate is expressed in terms of the percentage of the appliance's full charge that would be lost over a 12-month period if the current rate of loss were to continue over that period. The rate must be calculated using one of the following methods. The same method must be used for all appliances subject to the leak repair requirements located at an operating facility.

(1) Annualizing Method.

(i) *Step 1*. Take the number of pounds of refrigerant added to the appliance to return it to a full charge, whether in one addition or in multiple additions related to same leak, and divide it by the number of pounds of refrigerant the appliance normally contains at full charge;

(ii) *Step 2*. Take the shorter of the number of days that have passed since the last day refrigerant was added or 365 days and divide that number by 365 days;

(iii) *Step 3*. Take the number calculated in Step 1 and divide it by the number calculated in Step 2; and

(iv) *Step 4*. Multiply the number calculated in Step 3 by 100 to calculate a percentage. This method is summarized in the following formula:

$$\text{Leak rate (\% per year)} = \frac{\text{pounds of refrigerant added}}{\text{pounds of refrigerant in full charge}} \times \frac{365\ \textit{days/year}}{\textit{shorter}\text{ of: \# days since refrigerant last added or 365 days}} \times 100\%$$

(2) Rolling Average Method.

(i) *Step 1*. Take the sum of the pounds of refrigerant added to the appliance over the previous 365-day period (or over the period that has passed since the last successful follow-up verification test showing all identified leaks in the appliance were repaired, if that period is less than one year);

(ii) *Step 2*. Divide the result of Step 1 by the pounds of refrigerant the appliance normally contains at full charge; and

(iii) *Step 3*. Multiply the result of Step 2 by 100 to obtain a percentage. This method is summarized in the following formula:

$$\text{Leak rate (\% per year)} = \frac{\text{pounds of refrigerant added over past 365 days (or since the last successful follow-up verification test showing all identified leaks in the appliance were repaired, if that period is less than one year)}}{\text{pounds of refrigerant in full charge}} \times 100\%$$

Mothball, as it relates to a refrigerant-containing appliance, means to evacuate refrigerant from an appliance, or the affected isolated section or component of an appliance, to at least atmospheric pressure, and to temporarily shut down that appliance.

Motor vehicle, as used in this subpart, means any vehicle which is self-propelled and designed for transporting persons or property on a street or highway, including but not limited to passenger cars, light-duty vehicles, and heavy-duty vehicles. This definition does not include a vehicle where final assembly of the vehicle has not been completed by the original equipment manufacturer.

Motor vehicle air conditioners (MVAC) means mechanical vapor compression refrigerant-containing appliances used to cool the driver's or passenger's compartment of any motor vehicle. This definition is intended to have the same meaning as in 40 CFR 82.32.

MVAC-like appliance means a mechanical vapor compression, open-drive compressor refrigerant-containing appliance with a full charge of 20 pounds or less of refrigerant used to cool the driver's or passenger's compartment of off-road vehicles. This includes, but is not limited to, the air-conditioning appliances found on agricultural or construction vehicles. This definition is intended to have the same meaning as defined in 40 CFR 82.152.

Normal operating characteristics and conditions, as it relates to a refrigerant-containing appliance, means appliance operating temperatures, pressures, fluid flows, speeds, and other characteristics, including full charge of the appliance, that would be expected for a given process load and ambient condition during normal operation. Normal operating characteristics and conditions are marked by the absence of atypical conditions affecting the operation of the appliance.

Owner or operator means any person who owns, leases, operates, or controls any equipment, or who controls or supervises any practice, process, or activity that is subject to any requirement pursuant to this subpart.

Recover means the process by which a regulated substance, or where applicable, a substitute for a regulated substance, is removed, in any condition, from equipment; and stored in an external container, with or without testing or processing the regulated substance or substitute for a regulated substance.

Recycling, when referring to fire suppression or fire suppressants, means the testing and/or reprocessing of regulated substances used in the fire suppression sector to certain purity standards.

Refrigerant, for purposes of this subpart, means any substance, including blends and mixtures, consisting in part or whole of a regulated substance or a substitute for a regulated substance that is used for heat transfer purposes and provides a cooling effect.

Refrigerant circuit, as it relates to a refrigerant-containing appliance, means the parts of an appliance that are normally connected to each other (or are separated only by internal valves) and are designed to contain refrigerant.

Refrigerant-containing appliance means any device that contains and uses a regulated substance or substitute for a regulated substance as a refrigerant including but not limited to any air conditioner, motor vehicle air conditioner, refrigerator, chiller, or freezer. For equipment with multiple circuits, each independent circuit is considered a separate appliance.

Refrigerant-containing equipment means equipment as defined in this subpart that contains, uses, or is otherwise connected or associated with a regulated substance or substitute for a regulated substance that is used as a refrigerant. This definition includes refrigerant-containing components, refrigerant-containing appliances, and MVAC-like appliances. This term does not include military equipment used in deployable and expeditionary situations. This term also does not include space vehicles as defined in 40 CFR 84.3.

Repackager means an entity who transfers regulated substances, either alone or in a blend, from one container to another container prior to sale or distribution or offer for sale or distribution. An entity that services system cylinders for use in fire suppression equipment and returns the same regulated substances to the same system cylinder it was recovered from after the system cylinder is serviced is not a repackager.

Repair, for purposes of this subpart and as it relates to a particular leak in a refrigerant-containing appliance, means making adjustments or other alterations to that refrigerant-containing appliance that have the effect of stopping leakage of refrigerant from that particular leak.

Reprocess means using procedures such as filtering, drying, distillation, and other chemical procedures to remove impurities from a regulated substance or a substitute for a regulated substance.

Retire, as it relates to a refrigerant-containing appliance, means the removal of the refrigerant and the disassembly or impairment of the refrigerant circuit such that the appliance as a whole is rendered unusable by any person in the future.

Retrofit, as it relates to a refrigerant-containing appliance, means to convert an appliance from one refrigerant to another refrigerant. Retrofitting includes the conversion of the appliance to achieve system compatibility with the new refrigerant and may include, but is not limited to, changes in lubricants, gaskets, filters, driers, valves, o-rings, or appliance components.

Seasonal variance, as it relates to a refrigerant-containing appliance, means the removal of refrigerant from an appliance due to a change in ambient conditions caused by a change in season, followed by the subsequent addition of an amount that is less than or equal to the amount of refrigerant removed in the prior change in season, where both the removal and addition of refrigerant occurs within one consecutive 12-month period.

Stationary refrigerant-containing equipment means refrigerant-containing equipment, as defined in this subpart, that is not a motor vehicle air conditioner or an MVAC-like appliance, as defined in this subpart.

Substitute for a regulated substance means a substance that can be used in equipment in the same or similar applications as a regulated substance, to serve the same or a similar purpose, including but not limited to a substance used as a refrigerant in a refrigerant-containing appliance or as a fire suppressant in fire suppression equipment, provided that the substance is not a regulated substance or an ozone-depleting substance.

Technician, as it relates to any person who works with refrigerant-containing appliances, means any person who in the course of servicing, repair, or installation of a refrigerant-containing appliance (except MVACs) could be reasonably expected to violate the integrity of the refrigerant circuit and therefore release refrigerants into the environment. Technician also means any person who in the course of disposal of a refrigerant-containing appliance (except small appliances as defined in 40 CFR 82.152, MVACs, and MVAC-like appliances) could be reasonably expected to violate the integrity of the refrigerant circuit and therefore release refrigerants from the appliances into the environment. Activities reasonably expected to violate the integrity of the refrigerant circuit include but are not limited to: Attaching or detaching hoses and gauges to and from the appliance; adding or removing refrigerant; adding or removing components; and cutting the refrigerant line. Activities such as painting the appliance, rewiring an external electrical circuit, replacing insulation on a length of pipe, or tightening nuts and bolts are not reasonably expected to violate the integrity of the refrigerant circuit. Activities conducted on refrigerant-containing appliances that have been properly evacuated pursuant to 40 CFR 82.156 are not reasonably expected to release refrigerants unless the activity includes adding refrigerant to the appliance. Technicians could include but are not limited to installers, contractor employees, in-house service personnel, and owners and/or operators of refrigerant-containing appliances.

Virgin regulated substance means any regulated substance that has not had any bona fide use in equipment.

§ 84.104 Prohibitions.

(a) *Sale of recovered refrigerant*. No person may sell, distribute, or transfer to a new owner, or offer for sale, distribution, or transfer to a new owner, any regulated substance used as a refrigerant in stationary refrigerant-containing equipment consisting in whole or in part of recovered regulated substances, unless the recovered regulated substance:

(1) Has been reclaimed by a person who has been certified as a reclaimer under 40 CFR 82.164 and has been reclaimed to the levels as specified in appendix A to 40 CFR part 82, subpart F; or

(2) Is sold, distributed, or transferred to a new owner, or offered for sale, distribution, or transfer to a new owner solely for the purposes of being reclaimed or destroyed.

(b) [Reserved]

§ 84.106 Leak repair.

(a) *Applicability*. This section applies to refrigerant-containing appliances with a full charge of 15 or more pounds of refrigerant where the refrigerant contains:

(1) A regulated substance as listed in subsection (c) of the AIM Act or in appendix A to part 84,

(2) A substitute for a regulated substance that has a global warming potential greater than 53, based on the global warming potentials listed in Table 1 of 40 CFR 84.64(b).

(3) Notwithstanding the criteria in paragraphs (1) and (2), the requirements of this section do not apply to:

(i) Appliances (as defined in 40 CFR 82.152) containing solely an ozone-depleting substance as a refrigerant;

(ii) Refrigerant-containing appliances used for the residential and light commercial air conditioning and heat pump subsector.

(4) The requirements of this section apply January 1, 2026.

(b) *Leak rate calculation*. Persons adding or removing refrigerant from a refrigerant-containing appliance must, upon conclusion of that installation, service, repair, or disposal provide the owner or operator with documentation that meets the applicable requirements of paragraph (l)(2) of this section. The owner or operator must calculate the leak rate every time refrigerant is added to an appliance unless the addition is made immediately following a retrofit, installation of a new refrigerant-containing appliance, or qualifies as a seasonal variance. The owner or operator may change the leak calculation methodology if requirements of paragraph (3) are met.

(1) Where an owner or operator is using the annualizing method to calculate a leak rate for a refrigerant-containing appliance for the first time after January 1, 2026, the calculation should substitute 365 days as the number of days since last refrigerant addition.

(2) Where an owner or operator is using the rolling average method to calculate a leak rate for a refrigerant-containing appliance for the first time after January 1, 2026, the calculation should substitute pounds of refrigerant added since January 1, 2026.

(3) An owner or operator may switch to a different leak rate calculation methodology once if:

(i) The owner or operator has purchased an operating facility with a refrigerant-containing appliance(s) which was previously using a different leak rate calculation methodology;

(ii) The owner or operator has determined the refrigerant-containing appliance(s) at the operating facility are not exceeding the applicable leak rate in paragraph (c)(2) of this section when both leak rate calculation methodologies are applied; and

(iii) The owner or operator must retain a record of this change as described in section (l)(3)

(c) *Requirement to address leaks through repair, or retrofitting or retiring a refrigerant-containing appliance.*

(1) Owners or operators must repair leaks in refrigerant-containing appliances with a leak rate over the applicable leak rate in this paragraph in accordance with paragraphs (d) through (f) of this section unless the owner or operator elects to retrofit or retire the refrigerant-containing appliance in compliance with paragraphs (h) and (i) of this section. If the owner or operator elects to repair leaks but fails to bring the leak rate below the applicable leak rate, the owner or operator must create and implement a retrofit or retirement plan in accordance with paragraphs

(h) and (i) of this section. Repairs must be conducted by a certified technician, as defined in this subpart.

(2) Leak rates:

(i) 20 percent leak rate for commercial refrigeration appliances;

(ii) 30 percent leak rate for industrial process refrigeration appliances; and

(iii) 10 percent leak rate for comfort cooling appliances, refrigerated transport appliances, or other refrigerant-containing appliances with a full charge of 15 or more pounds of refrigerant not covered by (c)(2)(i) or (ii) of this section.

(d) *Appliance repair*. Owners or operators must identify and repair leaks in accordance with this paragraph within 30 days (or 120 days if an industrial process shutdown is required) of when refrigerant is added to a refrigerant-containing appliance exceeding the applicable leak rate in paragraph (c) of this section.

(1) A certified technician must conduct a leak inspection, as described in paragraph (g) of this section, to identify the location of leaks.

(2) Leaks must be repaired such that the leak rate of the refrigerant-containing appliance is brought below the applicable leak rate. This must be confirmed by the leak rate calculation performed upon the next refrigerant addition. Leak repairs will be presumed to be successful if, over the 12-month period after the date of a successful follow-up verification test, there is no further refrigerant addition or if the leak inspections required under paragraph (g) and/or automatic leak detection systems required by § 84.108 do not find any leaks in the appliance. Repairs of leaks must be documented by both an initial and a follow-up verification test or tests.

(3) The time frames in paragraphs (d) through (f) of this section are temporarily suspended when an appliance is mothballed. The time will resume on the day additional refrigerant is added to the

refrigerant-containing appliance (or component of a refrigerant-containing appliance if the leaking component was isolated).

(e) *Verification tests*. The owner or operator must conduct both initial and follow-up verification tests on each leak that was repaired under paragraph (d) of this section.

(1) *Initial verification test*. Unless granted additional time, an initial verification test must be performed within 30 days (or 120 days if an industrial process shutdown is required) of a refrigerant-containing appliance exceeding the applicable leak rate in paragraph (c) of this section. An initial verification test must demonstrate that for leaks where repair attempts were made, the adjustments or alterations to the refrigerant-containing appliance have held.

(i) For repairs that can be completed without the need to open or evacuate the refrigerant-containing appliance, the test must be performed after the conclusion of the repairs and before any additional refrigerant is added to the refrigerant-containing appliance.

(ii) For repairs that require the evacuation of the refrigerant-containing appliance or portion of the refrigerant-containing appliance, the test must be performed before adding any refrigerant to the refrigerant-containing appliance.

(iii) If the initial verification test indicates that the repairs have not been successful, the owner or operator may conduct as many additional repairs and initial verification tests as needed within the applicable time period.

(2) *Follow-up verification test*. A follow-up verification test must be performed within 10 days of the successful initial verification test or 10 days of the refrigerant-containing appliance reaching normal operating characteristics and conditions (if the refrigerant-containing appliance or isolated component was evacuated for the repair(s)). Where it is unsafe to be present or otherwise impossible to conduct a follow-up verification test when the system is operating at

normal operating characteristics and conditions, the verification test must, where practicable, be conducted prior to the system returning to normal operating characteristics and conditions.

(i) A follow-up verification test must demonstrate that leaks where repair attempts were made are repaired. If the follow-up verification test indicates that the repairs have not been successful, the owner or operator may conduct as many additional repairs and verification tests as needed to bring the refrigerant-containing appliance below the leak rate within the applicable time period and to verify the repairs.

(f) *Extensions to the appliance repair deadlines*. Owners or operators are permitted more than 30 days (or 120 days if an industrial process shutdown is required) to comply with paragraphs (d) and (e) of this section if they meet the requirements of (f)(1) through (4) of this section or the refrigerant-containing appliance is mothballed. Extension requests must be signed by an authorized company official. The request will be considered approved unless EPA notifies the owners or operators otherwise.

(1) One or more of the following conditions must apply:

(i) The refrigerant-containing appliance is located in an area subject to radiological contamination or shutting down the refrigerant-containing appliance will directly lead to radiological contamination. Additional time is permitted to the extent needed to conduct and finish repairs in a safe working environment.

(ii) Requirements of other applicable Federal, state, local, or Tribal regulations make repairs within 30 days (or 120 days if an industrial process shutdown is required) impossible. Additional time is permitted to the extent needed to comply with the pertinent regulations.

(iii) Components that must be replaced are not available within 30 days (or 120 days if an industrial process shutdown is required). Additional time is permitted up to 30 days after receiving delivery of the necessary components, not to exceed 180 days (or 270 days if an industrial process shutdown is required) from the date the refrigerant-containing appliance exceeded the applicable leak rate.

(2) Repairs to leaks that the technician has identified as significantly contributing to the exceedance of the leak rate and that do not require additional time must be completed and verified within the initial 30-day repair period (or 120-day repair period if an industrial process shutdown is required);

(3) The owner or operator must document all repair efforts and the reason for the inability to make all necessary repairs within the initial 30-day repair period (or 120-day repair period if an industrial process shutdown is required); and

(4) The owner or operator must request an extension from EPA electronically, in the manner specified by EPA, within 30 days (or 120 days if an industrial process shutdown is required) of the refrigerant-containing appliance exceeding the applicable leak rate in paragraph (c) of this section. Extension requests must include: Identification and address of the facility; the name of the owner or operator of the refrigerant-containing appliance; the leak rate; the method used to determine the leak rate and full charge; the date the refrigerant-containing appliance exceeded the applicable leak rate; the location of leak(s) to the extent determined to date; any repairs that have been performed thus far, including the date that repairs were completed; the reasons why more than 30 days (or 120 days if an industrial process shutdown is required) are needed to complete the repairs; an estimate of when the repairs will be completed; and a signature from an authorized company official. If the estimated completion date is to be extended, a new estimated date of completion and documentation of the reason for that change must be submitted to EPA

within 30 days of identifying that the completion date must be extended. The owner or operator must keep a dated copy of this submission.

(g) *Leak inspections*. (1) The owner or operator must conduct a leak inspection in accordance with the following schedule on any refrigerant-containing appliance exceeding the applicable leak rate in paragraph (c)(2) of this section.

(i) For commercial refrigeration and industrial process refrigeration appliances with a full charge of 500 or more pounds, leak inspections must be conducted once every three months after the date of a successful follow-up verification test, until the owner or operator can demonstrate through the leak rate calculations required under paragraph (b) of this section that the appliance has not leaked in excess of the applicable leak rate for four quarters in a row.

(ii) For commercial refrigeration and industrial process refrigeration appliances with a full charge of 50 or more pounds but less than 500 pounds, leak inspections must be conducted once per year after the date of a successful follow-up verification test, until the owner or operator can demonstrate through the leak rate calculations required under paragraph (b) of this section that the appliance has not leaked in excess of the applicable leak rate for one year.

(iii) For comfort cooling appliances and other appliances not covered by paragraphs (g)(1)(i) and (ii) of this section, leak inspections must be conducted once per year after the date of a successful follow-up verification test, until the owner or operator can demonstrate through the leak rate calculations required under paragraph (b) of this section that the appliance has not leaked in excess of the applicable leak rate for one year.

(2) Leak inspections must be conducted by a certified technician using method(s) determined by the certified technician to be appropriate for that refrigerant-containing appliance.

(3) All visible and accessible components of a refrigerant-containing appliance must be inspected, with the following exceptions:

(i) Where components are insulated, under ice that forms on the outside of equipment, underground, behind walls, or are otherwise inaccessible;

(ii) Where personnel must be elevated more than two meters above a support surface; or

(iii) Where components are unsafe to inspect, as determined by site personnel.

(4) Quarterly or annual leak inspections are not required on refrigerant-containing appliances, or portions of refrigerant-containing appliances, continuously monitored by an automatic leak detection system that is audited or calibrated annually. An automatic leak detection system may directly detect refrigerant in air, monitor its surrounding in a manner other than detecting refrigerant concentrations in air, or monitor conditions of the appliance. An automatic leak detection system being used for this purpose must meet the requirements for automatic leak detection systems in § 84.108(c) through (g) and § 84.108(i).

(i) When an automatic leak detection system is only being used to monitor portions of a refrigerant-containing appliance, the remainder of the refrigerant-containing appliance continues to be subject to any applicable leak inspection requirements.

(ii) [Reserved]

(h) *Retrofit or retirement plans*. (1) The owner or operator must create a retrofit or retirement plan within 30 days of:

(i) A refrigerant-containing appliance leaking above the applicable leak rate in paragraph (c) of this section if the owner or operator intends to retrofit or retire rather than repair leaks;

(ii) A refrigerant-containing appliance leaking above the applicable leak rate in paragraph (c) of this section if the owner or operator fails to take any action to identify or repair leaks; or

(iii) A refrigerant-containing appliance continues to leak above the applicable leak rate after having conducted the required repairs and verification tests under paragraphs (d) and (e) of this section.

(2) A retrofit or retirement plan must, at a minimum, contain the following information:

(i) Identification and location of the refrigerant-containing appliance;

(ii) Type and full charge of the refrigerant used in the refrigerant-containing appliance;

(iii) Type and full charge of the refrigerant to which the refrigerant-containing appliance will be converted, if retrofitted;

(iv) Itemized procedure for converting the refrigerant-containing appliance to a different refrigerant, including changes required for compatibility with the new substitute, if retrofitted;

(v) Plan for the disposition of recovered refrigerant;

(vi) Plan for the disposition of the refrigerant-containing appliance, if retired; and

(vii) A schedule, not to exceed one year, for completion of the appliance retrofit or retirement.

(3) The retrofit or retirement plan must be signed by an authorized company official, dated, accessible at the site of the refrigerant-containing appliance in paper copy or electronic format, and available for EPA inspection upon request.

(4) All identified leaks must be repaired as part of any retrofit under such a plan.

(5) A retrofit or retirement plan must be implemented as follows:

(i) Unless granted additional time, all work performed in accordance with the plan must be finished within one year of the plan's date (not to exceed 12 months from when the plan was finalized as required in paragraph (h)(1) of this section).

(ii) The owner or operator may request that EPA relieve it of the obligation to retrofit or retire a refrigerant-containing appliance if the owner or operator can establish within 180 days of the plan's date that the refrigerant-containing appliance no longer exceeds the applicable leak rate and if the owner or operator agrees in writing to repair all identified leaks within one year of the plan's date consistent with paragraph (h)(4) and (h)(5)(i) of this section. The owner or operator must submit to EPA the retrofit or retirement plan as well as the following information: The date that the requirement to develop a retrofit or retirement plan was triggered; the leak rate; the method used to determine the leak rate and full charge; the location of the leak(s) identified in the leak inspection; a description of repair that has been completed; a description of repairs that have not been completed; a description of why repairs were not conducted within the time frames required under paragraphs (d) and (f) of this section; and a statement signed by an authorized company official that all identified leaks will be repaired and an estimate of when those repairs will be completed (not to exceed one year from date of the plan). The request will be considered approved unless EPA notifies the owners or operators within 60 days of receipt of the request that it is not approved.

(i) *Extensions to the one-year retrofit or retirement schedule.* Owners or operators may request more than one year to comply with paragraph (h) of this section if they meet the requirements of this paragraph. The request will be considered approved unless EPA notifies the owners or operators within 60 days of receipt of the request that it is not approved. The request must be submitted to EPA electronically, in the manner specified by EPA, within seven months of discovering the refrigerant-containing appliance exceeded the applicable leak rate. The request must include the identification of the refrigerant-containing appliance; name of the owner or operator; the leak rate; the method used to determine the leak rate and full charge; the date the refrigerant-containing appliance exceeded the applicable leak rate; the location of leaks(s) to the extent determined to date; any repairs that have been finished thus far, including the date that repairs were finished; a plan to finish the retrofit or retirement of the refrigerant-containing appliance; the reasons why more than one year is necessary to retrofit or retire the refrigerant-containing appliance; the date of notification to EPA; a signature from an authorized company official; and an estimate of when the retrofit or retirement will be finished. A dated copy of the request must be available on-site in either electronic or paper copy. If the estimated completion date is to be revised, a new estimated date of completion and documentation of the reason for that change must be submitted to EPA electronically, in the manner specified by EPA, within 30 days. Additionally, the time frames in paragraphs (h) and (i) of this section are temporarily suspended when a refrigerant-containing appliance is mothballed. The time will resume running on the day additional refrigerant is added to the refrigerant-containing appliance (or component of a refrigerant-containing appliance if the leaking component was isolated).

(1) Extensions available to industrial process refrigeration. Owners or operators of industrial process refrigeration appliances may request additional time beyond the one-year period in paragraph (h) of this section to finish the retrofit or retirement under the following circumstances.

(i) Requirements of other applicable Federal, state, local, or Tribal regulations make a retrofit or retirement within one year impossible. Additional time is permitted to the extent needed to comply with the pertinent regulations;

(ii) The new or the retrofitted equipment is custom-built as defined in this subpart and the supplier of the appliance or one of its components has quoted a delivery time of more than 30 weeks from when the order is placed. The appliance or appliance components must be installed within 120 days after receiving delivery of the necessary parts;

(iii) The equipment or component is located in an area subject to radiological contamination and creating a safe working environment will require more than 30 weeks; or
(iv) After receiving an extension under paragraph (i)(1)(ii) of this section, owners or operators may request additional time if necessary to finish the retrofit or retirement of the refrigerant-containing appliance. The request must be submitted to EPA before the end of the ninth month of the initial extension and must include the same information submitted for that extension, with any necessary revisions. A dated copy of the request must be available on-site in either electronic or paper copy. The request will be considered approved unless EPA notifies the owners or operators within 60 days of receipt of the request that it is not approved.
(2) [Reserved]
(j) *Chronically leaking appliances*. Owners or operators of refrigerant-containing appliances containing 15 or more pounds of refrigerant that leak 125 percent or more of the full charge in a calendar year must submit a report containing the information required in (m)(4) to EPA by March 1 of the subsequent year.
(k) *Purged refrigerant*. In calculating annual leak rates, purged refrigerant that is destroyed at a verifiable destruction efficiency of 98 percent or greater will not be counted toward the leak rate.
(l) *Recordkeeping*. All records identified in this paragraph must be kept for at least three years in electronic or paper format, unless otherwise specified.
(1) By January 1, 2026, or upon installation for refrigerant-containing appliance installed on or after January 1, 2026, owners or operators must determine the full charge of all refrigerant-containing appliances with 15 or more pounds of refrigerant and maintain the following information for each appliance until three years after the appliance is retired:
(i) The identification of the owner or operator of the refrigerant-containing appliance;

(ii) The address where the appliance is located;

(iii) The full charge of the refrigerant-containing appliance and the method for how the full charge was determined;

(iv) If using method 4 (using an established range) for determining full charge, records must include the range for the full charge of the refrigerant-containing appliance, its midpoint, and how the range was determined;

(v) Any revisions of the full charge, how they were determined, and the dates such revisions occurred; and

(vi) The date of installation.

(2) Owners or operators must maintain a record including the following information for each time a refrigerant-containing appliance with a full charge of 15 or more pounds is installed, serviced, repaired, or disposed of, when applicable.

(i) The identity and location of the refrigerant-containing appliance;

(ii) The date of the installation, service, repair, or disposal performed;

(iii) The part(s) of the refrigerant-containing appliance being installed, serviced, repaired, or disposed;

(iv) The type of installation, service, repair, or disposal performed for each part;

(v) The name of the person performing the installation, service, repair, or disposal;

(vi) The amount and type of refrigerant added to, or in the case of disposal removed from, the appliance;

(vii) The full charge of the refrigerant-containing appliance; and

(viii) The leak rate and the method used to determine the leak rate (not applicable when disposing of the refrigerant-containing appliance, following a retrofit, installing a new refrigerant-containing appliance, or if the refrigerant addition qualifies as a seasonal variance).

(3) Owners or operators must maintain the following records of changes to the leak rate calculation method after a change in ownership specified in paragraph (b)(3) of this section:

(i) Basic identification information (*i.e.*, owner name or operator, facility name, facility address where appliance is located, and appliance ID or description);

(ii) The date an operating facility was purchased;

(iii) The leak rates for all refrigerant-containing appliances at the operating facility when both leak rate calculation methods are applied;

(iv) The date a new leak rate calculation method is adopted; and

(v) The leak rate calculation method the owner or operator is using after the change.

(4) If the installation, service, repair, or disposal is done by someone other than the owner or operator, that person must provide a record containing the information specified in paragraph (l)(2)(i) through (l)(2)(vi) of this section, when applicable, to the owner or operator.

(5) Owners or operators must keep records of leak inspections that include the date of inspection, the method(s) used to conduct the leak inspection, a list of the location of each leak that was identified, and a certification that all visible and accessible parts of the refrigerant-containing appliance were inspected. The certified technicians conducting the leak inspections must, upon conclusion of that service, provide the owner or operator of the refrigerant-containing appliance with documentation that meets these requirements.

(6) If using an automatic leak detection system, the owner or operator must maintain records regarding the installation and the annual audit and calibration of the system, a record of each date the monitoring system identified a leak, and the location of the leak.

(7) Owners or operators must maintain records of the dates and results of all initial and follow-up verification tests. Records must include the location of the refrigerant-containing appliance, the date(s) of the verification tests, the location(s) of all repaired leaks that were tested, the type(s) of verification test(s) used, and the results of those tests. The certified technicians conducting the initial or follow-up verification tests must, upon conclusion of that service, provide the owner or operator of the appliance with documentation that meets these requirements.

(8) Owners or operators must maintain retrofit or retirement plans developed in accordance with paragraph (h) of this section.

(9) Owners or operators must maintain retrofit and/or retirement extension requests submitted to EPA in accordance with paragraph (i) of this section.

(10) Owners or operators that suspend the deadlines in this section by mothballing a refrigerant-containing appliance must keep records documenting when the appliance was mothballed and when additional refrigerant was added to the appliance (or isolated component).

(11) Owners or operators who exclude purged refrigerants that are destroyed from annual leak rate calculations must maintain records to support the amount of refrigerant claimed as sent for destruction. Records must be based on a monitoring strategy that provides reliable data to demonstrate that the amount of refrigerant claimed to have been destroyed is not greater than the amount of refrigerant actually purged and destroyed and that the 98 percent or greater destruction efficiency is met. Records must include flow rate, quantity or concentration of the refrigerant in the vent stream, and periods of purge flow. Records must include:

(i) The identification of the facility and a contact person, including the address and telephone number;

(ii) A description of the refrigerant-containing appliance, focusing on aspects relevant to the purging of refrigerant and subsequent destruction;

(iii) A description of the methods used to determine the quantity of refrigerant sent for destruction and type of records that are being kept by the owners or operators where the appliance is located;

(iv) The frequency of monitoring and data-recording; and

(v) A description of the control device, and its destruction efficiency.

(12) Owners or operators that exclude additions of refrigerant due to seasonal variance from their leak rate calculation must maintain records stating that they are using the seasonal variance flexibility and documenting the amount added and removed under paragraph (l)(2) of this section.

(13) Owners or operators that submit reports to EPA in accordance with paragraph (m) of this section must maintain copies of the submitted reports and any responses from EPA.

(m) *Reporting*. All notifications must be submitted electronically in the manner specified by EPA.

(1) Owners or operators must notify EPA electronically, in the manner specified by EPA, in accordance with paragraph (f) of this section when seeking an extension of time to complete repairs.

(2) Owners or operators must notify EPA electronically, in the manner specified by EPA, in accordance with paragraph (h)(5)(ii) of this section when seeking relief from the obligation to retrofit or retire an appliance.

(3) Owners or operators must notify EPA electronically, in the manner specified by EPA, in accordance with paragraph (i) of this section when seeking an extension of time to complete the retrofit or retirement of an appliance.

(4) Owners or operators must report to EPA electronically, in a manner specified by EPA, the following in accordance with paragraph (j) of this section for any refrigerant-containing appliance that leaks 125 percent or more of the full charge in a calendar year.

(i) Basic identification information (*i.e.*, owner name or operator, facility name, facility address where appliance is located, and appliance ID or description);

(ii) Refrigerant-containing appliance type (comfort cooling or other, industrial process refrigeration, or commercial refrigeration);

(iii) Refrigerant type;

(iv) Full charge of appliance (pounds);

(v) Annual percent refrigerant loss;

(vi) Dates of refrigerant addition;

(vii) Amounts of refrigerant added;

(viii) Date of last successful follow-up verification test;

(ix) Explanation of cause refrigerant losses;

(x) Description of repair actions taken;

(xi) Whether a retrofit or retirement plan been developed for the refrigerant-containing appliance and if so, the anticipated date of retrofit or retirement; and

(xii) A signed statement from an authorized company official.

(5) When excluding purged refrigerants that are destroyed from annual leak rate calculations, owners or operators must notify EPA electronically, in the manner specified by EPA, within 60

days after the first time the exclusion is used by the facility where the appliance is located. The report must include the information included in paragraph (l)(11) of this section and must be signed by an authorized company official.

§ 84.108 Automatic leak detection systems.

(a) Owners or operators of refrigerant-containing appliances used for industrial process refrigeration or commercial refrigeration with a full charge of 1,500 pounds or greater of a refrigerant containing a regulated substance or a substitute for a regulated substance with a GWP greater than 53 must install and use an automatic leak detection system in accordance with this section.

(1) If the refrigerant in a refrigerant-containing appliance contains a substitute for a regulated substance, the global warming potential of the substitute will be determined as described in § 84.106(a)(2).

(2) [Reserved]

(b) (1) Owners and operators of refrigerant-containing appliances subject to paragraph (a) of this section installed on or after January 1, 2026, must install and use an automatic leak detection system upon installation of the refrigerant-containing appliance or within 30 days of installation of the refrigerant-containing appliance.

(2) Owners and operators of refrigerant-containing appliances subject to paragraph (a) of this section installed on or after January 1, 2017, and before January 1, 2026, must install and use an automatic leak detection system by January 1, 2027.

(c) Automatic leak detection systems must be installed in accordance with manufacturer instructions.

(d) Automatic leak detection systems must be audited and calibrated annually.

(e) Automatic leak detection systems are required to monitor components located inside an enclosed building or structure.

(f) For automatic leak detection systems that directly detect the presence of a refrigerant in air, the system must:

(1) Have sensors or intakes placed so that they will continuously monitor the refrigerant concentrations in air in proximity to the compressor, evaporator, condenser, and other areas with a high potential for a refrigerant leak;

(2) Accurately detect a concentration level of 10 parts per million of vapor of the specific refrigerant or refrigerants used in the refrigerant-containing appliance(s); and

(3) Alert the owner or operator when a refrigerant concentration of 100 parts per million of vapor of the specific refrigerant or refrigerants used in the appliance(s) is reached.

(g) For automatic leak detection systems that monitor conditions of the refrigerant-containing appliance, the system must automatically alert the owner or operator when measurements indicate a loss of 50 pounds of refrigerant or 10 percent of the full charge, whichever is less.

(h) When an automatic leak detection system alerts an owner or operator of a leak as described in this paragraph, owners and operators of refrigerant-containing appliances using automatic leak detection systems must:

(1) Calculate the leak rate within 30 days (or 120 days where an industrial process shutdown would be necessary) of an alert and, if the leak rate is above the applicable leak rate as described in § 84.106(c)(2), comply with the full suite of leak repair provisions in § 84.106; or

(2) Preemptively repair the identified leak before adding refrigerant to the appliance and then calculate the leak rate within 30 days (or 120 days where an industrial process shutdown would be necessary) of an alert. If the leak rate is above the applicable leak rate as described in §

84.106(c)(2), the owner or operator must comply with the full suite of leak repair provisions in § 84.106.

(3) Where a refrigerant-containing appliance using an automatic leak detection system is found to be leaking above the applicable leak rate as described in § 84.106(c)(2), and the automatic leak system is only being used to monitor portions of an appliance, the remainder of the appliance continues to be subject to any applicable leak inspection requirements, as described in § 84.106(g).

(i) *Recordkeeping*. The owner or operator must maintain records for at least three years in electronic or paper format, unless otherwise specified, regarding:

(1) The installation of the automatic leak detection system;

(2) The annual audit and calibration of the system;

(3) A record of each date the automatic leak detection system triggers an alert; and

(4) The location of the leak(s) which resulted in the alarm.

§ 84.110 Emissions from fire suppression equipment.

(a) As of January 1, 2026, no person installing, servicing, repairing, or disposing of fire suppression equipment containing a regulated substance may knowingly vent or otherwise release into the environment any regulated substances used in such equipment.

(1) Release of regulated substances during testing of fire suppression equipment is not subject to this prohibition under paragraph (a) of this section if the following four conditions are met:

(i) Equipment employing suitable alternative fire suppression agents are not available;

(ii) Release of fire suppression agent is essential to demonstrate equipment functionality;

(iii) Failure of the system or equipment would pose great risk to human safety or the environment; and

(iv) A simulant agent cannot be used in place of the regulated substance for testing purposes.

(2) This prohibition under paragraph (a) of this section does not apply to qualification and development testing during the design and development process of fire suppression equipment containing regulated substances when such tests are essential to demonstrate equipment functionality and when a suitable simulant agent cannot be used in place of the regulated substance for testing purposes.

(3) This prohibition does not apply to the emergency release of regulated substances for the legitimate purpose of fire extinguishing, explosion inertion, or other emergency applications for which the fire suppression equipment was designed.

(b) As of January 1, 2026, no owner or operator of fire suppression equipment containing regulated substances shall allow the release of regulated substances to occur as a result of failure to maintain such fire suppression equipment.

(c) As of January 1, 2030, recycled regulated substances must be used for the initial installation of new fire suppression equipment, including both total flooding systems and streaming applications, that is installed in the United States, and as of January 1, 2026, for the servicing and/or repair of existing fire suppression equipment in the United States, including both total flooding systems and streaming applications. Notwithstanding the prior sentence, if the fire suppression equipment does not use any regulated substance, this requirement does not apply. If the fire suppression equipment uses a regulated substance in combination with other fire suppression agents, this requirement will only apply to the regulated substance used. This requirement does not apply to onboard aerospace fire suppression applications, as listed at § 84.13(a), for a year or years for which that application receives an application-specific allowance as defined at § 84.3.

(1) Any person using a device to recover, store, and transfer regulated substances used in fire suppression equipment must evacuate the device used to recover, store, and transfer regulated substances prior to each use to prevent contamination, arrange for destruction of the recovered regulated substances as necessary, and collect and dispose of wastes from recycling process.

(2) Any person using recovery and recycling equipment to recover regulated substances from fire suppression equipment must:

(i) Operate and maintain recovery and recycling equipment in accordance with manufacturer specifications to ensure that the equipment performs as specified;

(ii) Repair leaks in storage, recovery, recycling, or charging equipment used with regulated substances before use; and

(iii) Ensure that cross-contamination does not occur through the mixing of regulated substances that may be contained in similar cylinders.

(d) Any person who employs fire suppression technicians who install, service, repair, or dispose of fire suppression equipment containing regulated substances shall train technicians hired on or before January 1, 2026, on emissions reduction of regulated substances by June 1, 2026. Fire suppression technicians hired after January 1, 2026, shall be trained regarding emissions reduction of regulated substances within 30 days of hiring, or by June 1, 2026, whichever is later.

(1) The fire suppression technician training shall cover an explanation of the purpose of the training requirement, including the following:

(i) The significance of minimizing releases of HFCs and ensuring technician safety;

(ii) An overview of regulated substances and environmental concerns with regulated substances, including other federal, state, local, or Tribal fire, building, safety, and environmental codes and standards;

(iii) A review of relevant regulations concerning regulated substances, including the requirements of the regulated substances emissions reduction program for fire suppression equipment, and

(iv) Specific technical instruction relevant to avoiding unnecessary emissions of regulated substances during the servicing, repair, disposal, or installation of fire suppression equipment at each individual facility.

(2) [Reserved]

(e) As of January 1, 2026, no person shall dispose of fire suppression equipment containing regulated substances except by recovering the regulated substances themselves or by arranging for the recovery of the regulated substances by a fire suppression equipment manufacturer, a distributor, or a fire suppressant recycler.

(f) As of January 1, 2026, no person shall dispose of regulated substances used as a fire suppression agent except by sending it for recycling to a fire suppressant recycler or a reclaimer certified under 40 CFR 82.164, or by arranging for its destruction using one of the controlled processes listed in § 84.29.

(g) (1) As of January 1, 2026, any person who performs first fill of fire suppression equipment, service (*e.g.*, recharge) of fire suppression equipment and/or recycles regulated substances recovered from fire suppression equipment, such as equipment manufacturers, distributors, agent suppliers or installers that recycle regulated substances must submit a report electronically, in a manner specified by EPA, to EPA annually by February 14 of each year, covering prior year's activity from January 1 through December 31 (after publication, the first annual report must be sent to the Agency on February 14, 2027): the quantity of material (the combined mass of regulated substance and contaminants) by regulated substance broken out by sold, recovered, recycled, and virgin for the purpose of installation of new fire suppression equipment and servicing and/or repair of existing fire suppression equipment; the total mass of each regulated substance broken out by sold, recovered, recycled, and virgin; and the total mass of waste products sent for disposal, along with information about the disposal facility if waste is not processed by the reporting entity. Such records must be maintained for three years in either electronic or paper format.

(2) As of January 1, 2026, any person who employs fire suppression technicians who service, repair, install, or dispose of fire suppression equipment containing regulated substances must maintain an electronic or paper copy of the fire suppression technician training used, and make available to EPA upon request a copy of the training. These entities must document that they have provided training to personnel and must maintain these records for three years in either electronic or paper format.

(3) As of January 1, 2026, owners and operators of fire suppression equipment containing regulated substances must maintain records documenting that regulated substances are recovered from the fire suppression equipment before it is sent for disposal, either by recovering the regulated substances themselves before sending the equipment for disposal or by leaving the regulated substances in the equipment and sending it for disposal to a facility, such as a fire suppression equipment manufacturer, distributor, or a fire suppressant recycler. Such records must be maintained for three years in either electronic or paper format.

§ 84.112 Reclamation.

(a) *Reclamation Standard.* No person may sell, identify, or report refrigerant as being reclaimed for use in the installation, servicing, or repair of refrigerant-containing equipment if the regulated substance component of the resulting refrigerant contains more than 15 percent, by weight, of virgin regulated substance.

(b) *Bona fide use.* No person may sell, identify, or report refrigerant as being reclaimed if it contains any recovered regulated substance that has not had bona fide use in refrigerant-containing equipment, unless that refrigerant was removed from the heel or residue of a container that had a bona fide use in the servicing, repair, or installation of refrigerant-containing equipment.

(c) *Labeling.* As of January 1, 2026, reclaimers certified under 40 CFR 82.164 must affix a label to any container being sold or distributed or offered for sale or distribution that contain reclaimed regulated substances to certify that the contents do not exceed 15 percent, by weight, of virgin regulated substances.

(1) The label must read: "The contents of this container do not exceed the limit of 15 percent, by weight, on virgin regulated substance per *40 CFR 84.112(a)*."

(2) The label must be:

(i) In English;

(ii) Durable and printed or otherwise labeled on, or affixed to, an external surface of the container;

(iii) Readily visible and legible;

(iv) Able to withstand open weather exposure without a substantial reduction in visibility or legibility; and

(v) Displayed on a background of contrasting color.

(d) *Recordkeeping*. As of January 1, 2026, reclaimers certified under 40 CFR 82.164 must generate a record to certify that the reclaimed regulated substances being used to fill a container that will be sold or distributed or offered for sale or distribution do not exceed 15 percent, by weight, of virgin regulated substances.

(1) The record must be generated electronically, in a format specified by EPA.

(2) The record must contain the following information:

(i) The name, address, contact person, email address, and phone number of the reclaimer certified under 40 CFR 82.164;

(ii) The date the container was filled with reclaimed regulated substance(s);

(iii) The amount and name of the regulated substance(s) in the container(s);

(iv) Certification that the contents of the container are from a batch where the amount of virgin regulated substances does not exceed 15 percent, by weight, of the total regulated substances;

(v) The unique serial number associated with the container(s) filled from the batch;

(vi) Identification of the batch of reclaimed regulated substances used to fill the container(s); and

(vii) The percent, by weight, of virgin regulated substance(s) in the batch used to fill the container(s).

(3) The record must be maintained by the reclaimer certified under 40 CFR 82.164 for three years.

(e) *Servicing and/or repair.* As of January 1, 2029, reclaimed refrigerant must be used when servicing and/or repairing refrigerant-containing equipment in the following subsectors, if the refrigerant-containing equipment serviced and/or repaired uses a refrigerant that contains a regulated substance:

(1) Supermarket systems;

(2) Refrigerated transport; and

(3) Automatic commercial ice makers.

(f) *Reporting*. (1) As of January 1, 2026, reclaimers, distributors, and wholesalers of reclaimed refrigerants that contain regulated substances that are sold for the intended purpose of servicing and/or repair of refrigerant-containing equipment in the subsectors listed in paragraph (e) must submit a report electronically, in a manner specified by EPA, to EPA by February 14, 2027, covering activity from January 1 through December 31, 2026, containing the following information: name and address of the company; contact person, email address, and phone number of the responsible party; the quantity of reclaimed refrigerant containing regulated substances by the name and volume of reclaimed refrigerant(s); and indication of the specific subsector(s) where the reclaimed refrigerant(s) containing HFC(s) are sold.

(2) As of January 1, 2027, reclaimers, distributors, and wholesalers of reclaimed refrigerants that contain regulated substances that are sold for the intended purpose of servicing and/or repair of refrigerant-containing equipment in the subsectors listed in paragraph (e) must submit a report electronically, in a manner specified by EPA, to EPA by February 14, 2028, covering activity from January 1 through December 31, 2027, containing the following information: name and address of the company; contact person, email address, and phone number of the responsible party; the quantity of reclaimed refrigerant containing regulated substances by the name and volume of reclaimed refrigerant(s); and indication of the specific subsector(s) where the reclaimed refrigerant(s) containing HFC(s) are sold.

§ 84.114 Exemptions.

(a) The regulations under this subpart do not apply to a regulated substance or a substitute for a regulated substance that is contained in a foam.

(b) The regulations under this subpart do not apply to two applications, mission-critical military end uses and onboard aerospace fire suppression, as listed at § 84.13(a), for a year or years for which that application receives an application-specific allowance as defined at § 84.3.

§ 84.116 Requirements for disposable cylinders.

(a) As of January 1, 2028, any person who uses a disposable cylinder must send such disposable cylinder for further processing to remove the heel, as described in paragraphs (b) and (c) of this section, when:

(1) The disposable cylinder contains a regulated substance;

(2) The disposable cylinder was used in the servicing, repair, or installation of refrigerant-containing equipment or fire suppression equipment; and

(3) The person does not intend to use the disposable cylinder in future servicing, repair, or installation of refrigerant-containing equipment or fire suppression equipment.

(b) Disposable cylinders that meet the criteria in paragraphs (a)(1), (a)(2), and (a)(3) of this section, unless meeting the criteria in paragraph (e) of this section, must be sent to:

(1) A reclaimer certified under 40 CFR 82.164,

(2) A fire suppressant recycler, if the disposable cylinder was used in the servicing, repair, or installation of fire suppression equipment,

(3) A final processor, such as a landfill operator or a scrap metal recycler, who is capable of removing the heel from disposable cylinders, or

(4) A refrigerant supplier (including, but not limited to distributors and wholesalers), who is capable of removing the heel from disposable cylinders.

(c) Regulated substances removed from heels of disposable cylinders by those entities identified in paragraphs (b)(3) and (b)(4) of this section, where those removed heels are or are not aggregated into a larger container, must be sent to a reclaimer certified under 40 CFR 82.164 or a fire suppressant recycler.

(1) Regulated substances removed from heels of disposable cylinders that exhibit ignitability characteristics (per 40 CFR 261.21), where those removed heels are or are not aggregated into a larger container, must be sent to a reclaimer certified under 40 CFR 82.164 that is in compliance with the requirements at 40 CFR part 266, subpart Q.

(d) As of January 1, 2028, a reclaimer certified under 40 CFR 82.164 or a fire suppressant recycler who receives a disposable cylinder meeting the criteria in paragraphs (a)(1), (a)(2), (a)(3), and (a)(4) of this section must remove all remaining contents from the disposable cylinder prior to discarding the disposable cylinder.

(e) Disposable cylinders that have been used in the service, repair, or installation of refrigerant-containing equipment or fire suppression equipment may be discarded to a final processor without meeting the requirements in paragraphs (b), (c), and (d), when:

(1) The heel was removed by a certified technician;

(2) The heel of the used disposable cylinder has been evacuated to a vacuum of 15 in-Hg;

(3) The certified technician provides a certification statement, which certifies that the heel was evacuated to a vacuum of 15 in-Hg; states the name and address of the certified technician who evacuated the cylinder(s) and the date the cylinder(s) was/were evacuated; and is signed by the certified technician who evacuated the cylinder(s); and

(4) The certified technician discarding the cylinder to the final processor must provide the signed certification statement to the final processor (which may include a landfill operator or scrap metal recycler) when they discard the cylinder to the final processor.

(f) *Recordkeeping.* A final processor who receives a disposable cylinder as described in paragraph (e) of this section must Maintain a record of the signed statement for three years.

(g) Small cans of refrigerant that contain no more than two pounds of refrigerant and that qualify for the exemption described in 40 CFR 82.154(c)(1)(ix) are not required to be sent to a reclaimer certified under 40 CFR 82.164 and such small cans are not required to have remaining regulated substance removed from them prior to being discarded.

§ 84.118 Treatment of data submitted under 40 CFR part 84, subpart C

(a) Except as otherwise provided in this section, 40 CFR 2.201 through 2.215 and 2.301 do not apply to data submitted under this subpart that EPA has determined through rulemaking to be either of the following:

(1) Emission data, as defined in 40 CFR 2.301(a)(2), determined in accordance with section 114(c) and 307(d) of the Clean Air Act; or

(2) Data not otherwise entitled to confidential treatment.

(b) Except as otherwise provided in paragraph (d) of this section, 40 CFR 2.201 through 2.208 and 2.301(c) and (d) do not apply to data submitted under this subpart that EPA has determined through rulemaking to be entitled to confidential treatment. EPA shall treat that information as confidential in accordance with the provisions of 40 CFR 2.211, subject to paragraph (d) of this section and 40 CFR 2.209.

(c) Upon receiving a request under 5 U.S.C. 552 for data submitted under this subpart that EPA has determined through rulemaking to be entitled to confidential treatment, the relevant Agency official shall furnish the requestor a notice that the information has been determined to be entitled to confidential treatment and that the request is therefore denied. The notice shall include or cite to the appropriate EPA determination.

(d) A determination made through rulemaking that information submitted under this subpart is entitled to confidential treatment shall continue in effect unless, subsequent to the confidentiality determination through rulemaking, EPA takes one of the following actions:

(1) EPA determines through a subsequent rulemaking that the information is emission data or data not otherwise entitled to confidential treatment; or

(2) The Office of General Counsel issues a final determination, based on the requirements of 5 U.S.C. 552(b)(4), stating that the information is no longer entitled to confidential treatment because of change in the applicable law or newly discovered or changed facts. Prior to making such final determination, EPA shall afford the business an opportunity to submit comments on pertinent issues in the manner described by 40 CFR 2.204(e) and 2.205(b). If, after consideration of any timely comments submitted by the business, the Office of General Counsel makes a revised final determination that the information is not entitled to confidential treatment, the relevant agency official will notify the business in accordance with the procedures described in 40 CFR 2.205(f)(2).

§ 84.120 Relationship to other laws.

Section (k) of the AIM Act states that sections 113, 114, 304, and 307 of the Clean Air Act (42 U.S.C. 7413, 7414, 7604, 7607) shall apply to this section and any rule, rulemaking, or regulation promulgated by the Administrator pursuant to this section as though this section were expressly included in title VI of that Act (42 U.S.C. 7671 *et seq*.). Violation of this part is subject to Federal enforcement and the penalties laid out in section 113 of the Clean Air Act.

PART 261—IDENTIFICATION AND LISTING OF HAZARDOUS WASTE

3. The authority citation for part 261 continues to read as follows:

Authority: 42 U.S.C. 6905, 6912(a), 6921, 6922, 6924(y), and 6938.

Subpart A—General

4. In § 261.6, revise paragraph (a)(2) and add paragraph (a)(2)(v) to read as follows:

§ 261.6 Requirements for recyclable materials.

(a) * * *

(2) The following recyclable materials are not subject to the requirements of this section but are regulated under subparts C through Q of part 266 of this chapter and all applicable provisions in parts 268, 270, and 124 of this chapter.

* * * * *

(v) Ignitable spent refrigerants recycled for reuse (40 CFR part 266, subpart Q).

* * * * *

Subpart M—Emergency Preparedness and Response for Management of Excluded Hazardous Secondary Materials

5. In § 261.400, revise the introductory text and add paragraph (c) to read as follows:

§ 261.400 Applicability.

The requirements of this subpart apply to (1) those areas of an entity managing hazardous secondary materials excluded under § 261.4(a)(23) and/or (24) where such materials are generated or accumulated on site, and (2) facilities regulated under the standards at § 266 subpart Q that receive ignitable spent refrigerant from off-site and that are not transfer facilities that store the refrigerants for less than ten (10) days.

* * * * *

(c) Facilities receiving refrigerant from off-site under § 266 subpart Q that are not transfer facilities that store the refrigerants for less than ten (10) days must comply with §§ 261.410 and 261.420.

* * * * *

6. In § 261.420, revise the header and introductory text to read as follows:

§ 261.420 Contingency planning and emergency procedures for facilities generating or accumulating more than 6000 kg of hazardous secondary material or receiving ignitable spent refrigerants

A generator or an intermediate or reclamation facility that generates or accumulates more than 6000 kg of hazardous secondary material, or a facility receiving refrigerant from off-site under § 266 subpart Q that is not a transfer facility that store the refrigerants for less than ten (10) days must comply with the following requirements:

* * *

* * * * *

PART 262—STANDARDS APPLICABLE TO GENERATORS OF HAZARDOUS WASTE

7. The authority citation for part 262 continues to read as follows:

Authority: 42 U.S.C. 6906, 6912, 6922-6925, 6937, 6938 and 6939g.

Subpart A—General

8. In § 262.14, revise paragraph (a)(5)(vi) to read as follows:

§ 262.14 Conditions for exemption for a very small quantity generator.

(a) * * *

(5) * * *

(vi) A facility which:

(A) (1) Beneficially uses or reuses, or legitimately recycles or reclaims its waste; or

(2) Treats its waste prior to beneficial use or reuse, or legitimate recycling or reclamation; and

(B) For ignitable spent refrigerants regulated under part 266 subpart Q, meets the requirements of that subpart.

* * * * *

PART 266—STANDARDS FOR THE MANAGEMENT OF SPECIFIC HAZARDOUS WASTES AND SPECIFIC TYPES OF HAZARDOUS WASTE MANAGEMENT FACILITIES

9. The authority citation for part 266 continues to read as follows:

Authority: 42 U.S.C. 1006, 2002(a), 3001-3009, 3014, 3017, 6905, 6906, 6912, 6921, 6922, 6924-6927, 6934, and 6937.

10. Add subpart Q, consisting of §§ 266.600 through 266.602, to read as follows:

Subpart Q—Ignitable Spent Refrigerants Recycled for Reuse

Sec.

§ 266.600 Purpose and applicability.

(a) The purpose of this subpart is to reduce emissions of ignitable spent refrigerants to the lowest achievable level by maximizing the recovery and safe recycling for reuse of such refrigerants during the service, repair, and disposal of appliances.

(b) The requirements of this subpart operate in lieu of parts 260 through 270 and apply to lower flammability spent refrigerants, as defined in § 266.601, where the refrigerant exhibits the hazardous waste characteristic of ignitability per § 261.21 and is being recycled for reuse in the United States.

(c) These requirements do not apply to other ignitable spent refrigerants. Ignitable spent refrigerants not subject to this subpart are subject to all applicable requirements of parts 260 through 270 when recovered (*i.e.*, removed from an appliance and stored in an external container) and/or disposed of.

§266.601 Definitions for this subpart.

For the purposes of this subpart, the following terms have the meanings given below:

(a) *Refrigerant* has the same meaning as defined in 40 CFR 82.152.

(b) *Ignitable spent refrigerant* is a used refrigerant that cannot be reused without first being processed, and that exhibits the hazardous characteristic of ignitability per § 261.21. Used refrigerants that can be legitimately reused without processing are not spent refrigerants.

(c) *Recycle for reuse*, when referring to an ignitable spent refrigerant, means to process the refrigerant to remove contamination and prepare it to be used again. “Recycle for reuse” does not include recycling that involves burning for energy recovery or use in a manner constituting disposal as defined in § 261.2(c), or sham recycling as defined in § 261.2(g).

(d) *Lower flammability spent refrigerant* means a spent refrigerant that is not considered highly flammable. Highly flammable refrigerants include but are not limited to the following chemicals: butane, isobutane, methane, propane, and/or propylene.

§ 266.602 Standards for ignitable spent refrigerant recycled for reuse under this subpart.

(a) Persons who recover (*i.e.*, remove from an appliance and store in an external container) and/or recycle ignitable spent refrigerants for reuse either for further use in equipment of the same owner, or in compliance with motor vehicle air conditioner (MVAC) standards in 40 CFR part 82, subpart B or who send recovered refrigerant off-site to be recycled for reuse must:

(1) Recover and/or recycle for reuse the ignitable spent refrigerant using equipment that is certified for that type of refrigerant and appliance under § 82.36 and/or 82.158; and

(2) Not speculatively accumulate the ignitable spent refrigerant per § 261.1(c).

(b) Persons who receive ignitable spent refrigerants from off-site, and are not a transfer facility that stores the refrigerants for less than ten (10) days, before sending the refrigerant to another site to be recycled for reuse must:

(1) If recovering the refrigerant, recover the ignitable spent refrigerant using equipment that is certified for that type of refrigerant and appliance under § 82.36;

(2) Meet the applicable emergency preparedness and response requirements of 40 CFR part 261, subpart M; and

(3) Not speculatively accumulate the ignitable spent refrigerant per § 261.1(c).

(c) Persons receiving ignitable spent refrigerant from off-site to be recycled for reuse under this subpart must:

(1) Maintain certification by EPA under § 82.164,

(2) Meet the applicable emergency preparedness and response requirements of 40 CFR part 261, subpart M; and

(3) Starting with the calendar year beginning January 1, 2029, not speculatively accumulate the ignitable spent refrigerant per § 261.1(c).

PART 270—EPA ADMINISTERED PERMIT PROGRAMS: THE HAZARDOUS WASTE PERMIT PROGRAM

11. The authority citation for part 270 continues to read as follows:

Authority: 42 U.S.C. 6905, 6912, 6924, 6925, 6927, 6939, and 6974.

Subpart A—General Information

12. In § 270.1, add paragraph (c)(2)(xi) to read as follows:

§ 270.1 Purpose and scope of the regulations in this part.

* * * * *

(c) * * *

(2) * * *

(xi) Recyclers of ignitable spent refrigerants subject to regulation under 40 CFR part 266, subpart Q.

* * * * *

PART 271—REQUIREMENTS FOR AUTHORIZATION OF STATE HAZARDOUS WASTE PROGRAMS

13. The authority citation for part 271 continues to read as follows:

Authority: 42 U.S.C. 6905, 6912(a), 6926, and 6939g.

Subpart A—Requirements for Final Authorization

14. In § 271.1:

a. In table 1 in paragraph (j)(2) add the entry "[Date of publication of the final rule in the Federal Register]" in chronological order.

b. In table 2 in paragraph (j)(2) add the entry "[Date of publication of the final rule in the Federal Register]" in chronological order.

The additions read as follows:

§ 271.1 Purpose and scope.

* * * * *

(j) * * *

(2) * * *

Table 1—Regulations Implementing the Hazardous and Solid Waste Amendments of 1984

Promulgation date	Title of regulation	Federal Register reference	Effective date
* * * * * * *			
[Date of publication of the final rule in the Federal Register]	Standards for the Management of Ignitable Spent Refrigerants Recycled for Reuse	**[Federal Register citation of the final rule]**	**[Date of publication of the final rule in the Federal Register]**

[1] These regulations implement HSWA only to the extent that they apply to tank systems owned or operated by small quantity generators, establish leak detection requirements for all new underground tank systems, and establish permitting standards for underground tank systems that cannot be entered for inspection.

[2] These regulations, including test methods for benzo(k)fluoranthene and technical standards for drip pads, implement HSWA only to the extent that they apply to the listing of Hazardous Waste No. F032, and wastes that are hazardous because they exhibit the Toxicity Characteristic. These regulations, including test methods for benzo(k)fluoranthene and technical standards for drip pads, do not implement HSWA to the extent that they apply to the listings of Hazardous Waste Nos. F034 and F035.

[3] The following portions of this rule are not HSWA regulations: §§ 264.19 and 265.19 for final covers.

[4] The following portions of this rule are not HSWA regulations: §§ 260.30, 260.31, 261.2.

[5] These regulations implement HSWA only to the extent that they apply to the standards for staging piles and to §§ 264.1(j) and 264.101(d) of this chapter.

Table 2—Self-Implementing Provisions of the Hazardous and Solid Waste Amendments of 1984

Effective date	Self-implementing provision	RCRA citation	Federal Register reference
* * * * * * *			
[Date of publication of the final rule in the Federal Register]	Standards for the Management of Ignitable Spent Refrigerants Recycled for Reuse	3001(d)(4) 3004(n)	**[Federal Register citation of the final rule]**

[1] Note that the effective date was changed to Jan. 29, 1986 by the Nov. 29, 1985 rule.

[2] Note that the effective date was changed to Sept. 22, 1986 by the Mar. 24, 1986 rule.

Draft Regulatory Impact Analysis Addendum:

Analysis of the Economic Impact and Benefits of the Final Rule: Management of Certain Hydrofluorocarbons and Substitutes Under Subsection (h) of the American Innovation and Manufacturing Act of 2020

U.S. Environmental Protection Agency
Stratospheric Protection Division
Office of Atmospheric Programs
1200 Pennsylvania Avenue, NW
Washington, DC 20460

May 2024

1. Contents

2. List of Tables

3. List of Acronyms

AC	Air conditioning
AIM Act	American Innovation and Manufacturing Act of 2020, codified at 42 U.S.C. § 7675
ALD	Automatic Leak Detection
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BAU	Business as usual
CAA	Clean Air Act
CARB	California Air Resources Board
CC	Comfort cooling
CFC	Chlorofluorocarbon
CO_2	Carbon dioxide
CONUS	Contiguous United States
CR	Commercial refrigeration
CWA	Clean Water Act
DSCIM	Data-driven Spatial Climate Impact Model
EAV	Equivalent annualized value
ECHO	Enforcement and Compliance History Online
EPA	Environmental Protection Agency
EO	Executive Order
ER&R	Emissions Reduction and Reclamation
FrEDI	Framework for Evaluating Damages and Impacts
FRS	Facility Registry Service
GDP	Gross Domestic Product
GHGs	Greenhouse gases
GIVE	Greenhouse Gas Impact Value Estimator
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbon
HFCs	Hydrofluorocarbons
HFOs	Hydrofluoroolefins
IAM	Integrated Assessment Model
ICR	Information Collection Request
IPCC	Intergovernmental Panel on Climate Change
IPR	Industrial process refrigeration
IWG	Interagency Working Group on the SC-GHG
MAC	Marginal abatement cost
MACC	Marginal abatement cost curve
MT	Metric ton
$MTCO_2eq$	Metric tons of CO_2 equivalent
$MMTCO_2eq$	Million metric tons of CO_2 equivalent
NPDES	National Pollutant Discharge Elimination System
NPRM	Notice of Proposed Rulemaking
NPV	Net Present Value

NSPS/EG	New Source Performance Standard / Emission Guidelines
ODS	Ozone-depleting substances
O&M	operations and maintenance
PV	Present value
RACHP	Refrigeration, AC, and heat pump
RCRA	Resource Conservation and Recovery Act
RIA	Regulatory Impact Analysis
RMP	Refrigerant Management Program
SBREFA	Small Business Regulatory Enforcement Fairness Act of 1996
SC-CH_4	Social Cost of Methane
SC-CO_2	Social Cost of Carbon
SC-GHG	Social Cost of Greenhouse Gases
SC-HFCs	Social cost of HFCs
SC-N_2O	Social Cost of Nitrous Oxide
SISNOSE	Substantial Number of Small Entities
U.S.	United States

Executive Summary

This Regulatory Impact Analysis (RIA) addendum provides an assessment of the costs and benefits of the final rule implementing provisions under subsection (h) of the American Innovation and Manufacturing Act of 2020, codified at 42 U.S.C. § 7675 (AIM Act or the Act), also referred to in this document as the Emissions Reduction and Reclamation (ER&R) rule. Subsection (h) of the AIM Act, entitled "Management of regulated substances," directs the United States (U.S.) Environmental Protection Agency (EPA) to promulgate regulations to control, where appropriate, any practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment that involves: a regulated substance (used interchangeably with "HFCs" in the final rulemaking and in this RIA addendum), a substitute for a regulated substance, the reclaiming of a regulated substance used as a refrigerant, or the reclaiming of a substitute for a regulated substance used as a refrigerant.

This rulemaking follows an already finalized rule issued separately under the AIM Act, *Phasedown of Hydrofluorocarbons: Establishing the Allowance Allocation and Trading Program Under the American Innovation and Manufacturing Act* (Allocation Framework Rule, 86 FR 55116, October 5, 2021), as well as a later rule for the same program, *Phasedown of Hydrofluorocarbons: Allowance Allocation Methodology for 2024 and Later Years* (2024 Allocation Rule, 88 FR 46836, July 20, 2023).[1] This rulemaking also follows the final rule issued under subsection (i) of the AIM Act, *Phasedown of Hydrofluorocarbons: Restrictions on the Use of Certain Hydrofluorocarbons Under the American Innovation and Manufacturing Act of 2020* (2023 Technology Transitions Rule, 88 FR 73098, October 24, 2023).[2] The analysis presented in the sections below provides estimated economic costs and environmental impacts of the provisions of the ER&R rule. The analysis also provides a comparison of these costs and benefits with those assessed for the previously finalized 2023 Technology Transitions and Allocation Rules to provide the public with an understanding of any potential changes in economic and environmental impacts relative to existing regulations. Results and methods from these analyses are referenced throughout this document. As with the 2024 Allocation Rule analysis and the 2023 Technology Transitions Rule analysis, this document is presented as an addendum to the original Allocation Framework RIA. In addition, for the purposes of identifying potential environmental justice issues, the analysis presents EPA's assessment of the characteristics of communities near facilities reclaiming HFCs that are expected to be affected by the rule.

[1] Throughout this document, we use "Allocation Framework RIA" and "2024 Allocation Rule RIA Addendum" to refer to the analyses of these rules. We use "Allocation Rules" and "Allocation Rules RIA" to refer to combined or cumulative effect of those two rules; i.e., the Allocation Framework RIA as updated by the 2024 Allocation Rule RIA Addendum.
[2] Throughout this document, we use "2023 Technology Transitions RIA" to refer to the analysis of this rule, noting this analysis included the Allocation Rules RIA as the reference case from which costs and benefits were derived.

This analysis is intended to provide the public with information on the relevant costs and benefits of this rule and to comply with executive orders. While significant, the estimated benefits detailed in this document are considered incidental and secondary to the rule's objectives of serving the purposes identified in subsection (h) of the AIM Act, including maximizing reclamation and minimizing releases of certain hydrofluorocarbons (HFCs) from equipment.

Climate Benefits

The climate benefits of this rule derive from reducing damages from climate change induced by reduced emissions of greenhouse gases (GHGs), specifically HFCs. The reduction in HFC emissions stem from provisions contained in the final rule aimed at maximizing reclamation and minimizing the release of certain HFCs and substitutes. The benefits of avoided climate damages are monetized using the same social cost of HFCs (SC-HFCs) estimates applied in the proposal RIA addendum and are presented in Table ES-1. As discussed in the proposal RIA the methodology underlying these SC-HFC estimates are consistent with the interim social cost of greenhouse gas (SC-GHG) estimates recommended by the Interagency Working Group on the SC-GHG (IWG) under Executive Order 13990. In our base case estimate of incremental climate benefits, the final rule's provisions are estimated to produce a present value (PV) of climate benefits of $8.4 billion over 2026 to 2050, in 2022 dollars and discounted to 2024 at 3 percent. We also present the net climate benefits using updated SC-HFC estimates that reflect scientific advances, including the latest evidence on appropriate consumption-based discounting for intergenerational impacts.

Compliance Costs

Incremental compliance costs stem from factors including industry transitions in service and maintenance practices as well as installation of equipment required to comply with provisions contained in the final rule. These include leak repair and inspection costs as well as Automatic Leak Detection (ALD) system costs for owners and operators of affected equipment. Incremental costs also stem from recordkeeping and reporting requirements detailed in the final rule. Reducing HFC emissions due to fixing leaks earlier will also be anticipated to lead to savings for some system owner/operators, as less new refrigerant would need to be purchased to replace leaked refrigerant. The estimated combined net incremental compliance costs (costs less anticipated savings) stemming from all provisions contained in the final rule are shown in Table ES-1 in 2022 dollars, discounted to 2024 at 2 percent, 3 percent, and 7 percent.[3] The present value of total compliance costs resulting from provisions contained in the rule is estimated to be $1.5 billion at a 2 percent discount rate, $1.3 billion at a 3 percent discount rate, or $0.9 billion at a 7 percent discount rate.

Net Benefits

The net benefits of the final rule are estimated as the climate benefits minus the net compliance costs (i.e., including any monetary benefits from reduced need of HFCs) in each year. Undiscounted annual costs, benefits, and net benefits for select years over the 2026–2050 time period are presented in Table ES-1, along with the present value and equivalent annualized value at various discount rates. End of year discounting is used throughout this document. When a discount rate of 2 percent is used for the costs, the present value of the incremental net benefits is estimated at $6.9 billion. When a discount rate of 3 percent is used for the costs, the present value of the incremental net benefits is estimated at $7 billion. When a discount rate of 7 percent is used for the costs, the present value of the incremental net benefits is estimated at $7.5 billion. These estimates are equivalent to $403-$404 million in incremental annual net benefits over a 25-year period.

Table ES-1 Summary of Undiscounted Annual Values, Present Values, and Equivalent Annualized Values select years for the 2026–2050 Timeframe for Estimated Compliance Costs, Benefits, and Net Benefits for this Rule (millions of 2022$, discounted to 2024) – Base Case Scenario [a,b,c,d,e]

Year	Climate Benefits	Costs			Net Benefits		
2026	$428	$92			$336		
2030	$676	$102			$574		
2035	$613	$87			$526		
2040	$466	$67			$399		
2045	$315	$51			$264		
2050	$263	$52			$211		
Discount rate	**3%**	**2%**	**3%**	**7%**	**2%**	**3%**	**7%**
PV	$8,356	$1,499	$1,335	$884	$6,857	$7,021	$7,471
EAV	$480	$77	$77	$76	$403	$403	$404

[3] Results using the 2 percent discount rate were not included in the analysis for the proposal for this action. The 2003 version of OMB's Circular A-4 had generally recommended 3 percent and 7 percent as default rates to discount social costs and benefits. The analysis of the proposed rule used these two recommended rates. In November 2023, OMB finalized an update to Circular A-4, in which it recommended the general application of a 2 percent rate to discount social costs and benefits (subject to regular updates), which is an estimate of consumption-based discount rate. Given the substantial evidence supporting a 2 percent discount rate, we include results calculated using a 2 percent discount rate consistent with the update to Circular A-4. While climate benefits are calculated using the same SC-HFC estimates used in the proposal RIA addendum, we also present in Appendix J the climate benefits of the final rule using a new set of SC-HFC estimates that incorporate recent research and methodological advances, including an updated approach to discounting intergenerational impacts.

[a] Benefits include only those related to climate. Climate benefits are based on changes (reductions) in HFC emissions and are calculated using four different estimates of the social cost of HFCs (SC-HFCs): model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate. For the presentational purposes of this table, we show the benefits associated with the average SC-HFC at a 3 percent discount rate. See Chapter 5 for more discussion of the SC-HFC methodology.
[b] Rows may not appear to add correctly due to rounding.
[c] Present values are calculated using end of year discounting.
[d] The annualized present value of costs and benefits are calculated as if they occur over a 25-year period.
[e] The PV for the net benefits column is found by taking the difference between the PV of climate benefits at 3 percent and the PV of costs discounted at 7 percent, 3 percent or 2 percent. Because the SC-HFC estimates reflect net climate change damages in terms of reduced consumption (or monetary consumption equivalents), the use of the social rate of return on capital (7 percent under OMB Circular A-4 (2003)) to discount damages estimated in terms of reduced consumption would inappropriately underestimate the impacts of climate change for the purposes of estimating the SC-HFC. See Chapter 5 for more discussion.

Relationship to Previously Estimated Results for Allocation Rules and 2023 Technology Transitions Rules

EPA has previously estimated costs and benefits of the HFC phasedown, which are detailed in the Allocation Framework RIA and 2024 Allocation Rule RIA Addendum. EPA has also estimated further incremental costs and benefits of the 2023 Technology Transitions Rule, detailed in 2023 Technology Transitions Rule RIA Addendum. The final ER&R Rule focuses on statutory provisions under the AIM Act that are separate from those addressed in the Allocation Framework Rule and 2023 Technology Transitions Rules. However, in order to avoid double counting or overestimating of costs and benefits, for the purposes of this analysis EPA's prior estimates are assumed to be the status quo from which incremental benefits may be calculated. Specifically, the compliance pathways and associated costs and benefits evaluated in the 2023 Technology Transitions Rule RIA Addendum serve as the reference case[4] for this analysis, thus ensuring that results presented in this document are reflective of the most up-to-date policy status quo.

As detailed in the Allocation Framework Rule RIA, 2024 Allocation Rule RIA Addendum, and 2023 Technology Transitions Rule RIA Addendum, EPA relied upon a marginal abatement cost curve (MACC) approach in order to estimate the full set of industry transitions and associated compliance costs required to meet statutory requirements. Analysis for this rule builds on this previously used methodology

[4] Incremental costs and benefits in this analysis calculated relative to a policy status quo derived from EPA's previous analyses conducted for the Allocation and 2023 Technology Transitions Rules. This status quo is referred to as a "reference case" rather than "baseline" throughout this document to avoid confusion with the statutory baseline for the Allocation Rules.

by adding on additional measures required by the final ER&R rule and evaluating their incremental impact relative to the previously modeled set of transitions.

Results from this analysis indicate that the final rule will yield incremental HFC emissions reductions relative to the previously modeled compliance pathways.[5] However, the extent of these incremental benefits depends in part on whether some of the HFC consumption- and emissions-reducing activities required by this final rule would have already been undertaken by industry in order to comply with, or otherwise address market outcomes from, the Allocation and 2023 Technology Transitions rules. As detailed in the 2023 Technology Transitions RIA Addendum, the precise set of transitions that will be undertaken by industry in response to both the Allocation and 2023 Technology Transitions Rules is uncertain, leading to a range in potential incremental benefits.

For the primary, base case analysis presented in this RIA Addendum, all measures found to be required to meet compliance with the Allocation and 2023 Technology Transitions Rules, based EPA's prior analyses, are assumed to occur in the reference case. Additional measures included in EPA's prior analyses as possible industry outcomes that are not explicitly required to meet compliance with the Allocation and 2023 Technology Transitions rules are excluded. These include measures such as improvements to leak repair, enhanced recovery, and transitions in the fire suppression sector. Given the uncertainty regarding whether industry may undertake these measures in the absence of explicit requirements, in Appendix F EPA has also provided an alternative scenario where we assume that these measures do occur as reference case assumptions, effectively illustrating a lower-bound of the incremental benefits of the final ER&R rule.

More details on these assumptions can be found in Chapter 3 as well as the appendices accompanying this document. Finally, EPA notes that these assumptions are made for technical analytic purposes and to avoid double counting of benefits. They should not be interpreted as a reflection of the merits of any particular provision contained in the final rule.

[5] However, the schedule for the production and consumption phasedown is not made more stringent than the schedule under subsection (e)(2)(C) of the AIM Act (i.e., the production and consumption caps contained in the Allocation Rules are unchanged).

Chapter 1. Introduction

1.1 Statutory Requirement

This Regulatory Impact Analysis (RIA) addendum evaluates the impact associated with the Final Rulemaking referred to in this document as the "Emissions Reduction and Reclamation" or ER&R rule. Under the American Innovation and Manufacturing Act of 2020 (the AIM) Act or the Act), the United States (U.S.) Environmental Protection Agency (EPA) is directed under subsection (h), "Management of Regulated Substances," to promulgate certain regulations for purposes that include maximizing reclamation and minimizing releases of certain hydrofluorocarbons (HFCs), those which are designated as regulated substances under the Act. Subsection (h)(1) of the AIM Act authorizes EPA to establish regulations to control, where appropriate, practices, processes, or activities regarding the servicing, repair, disposal, or installation of equipment, for purposes of maximizing the reclamation and minimizing the release of HFCs from equipment and ensuring the safety of technicians and consumers.

Among other things, subsection (h) also provides for the Agency to consider options to increase opportunities for reclaiming HFCs used as refrigerants and provides that the Agency may coordinate regulations carrying out subsection (h) of the AIM Act with similar EPA regulations. Those regulations could, for example, include those implementing the refrigerant management program established under Title VI of the Clean Air Act (CAA).

1.2 Summary of Regulatory Requirements

Pursuant to subsection (h) of the AIM Act, EPA is requiring the following:

- Applying a suite of leak repair requirements to refrigerant-containing appliances, including comfort cooling (CC) [6], commercial refrigeration (CR), and industrial process refrigeration (IPR) appliances, containing 15 or more pounds of a refrigerant containing a hydrofluorocarbon (HFCs) or a substitute for an HFC with a global warming potential (GWP) above 53 (e.g., would not apply to carbon dioxide (CO_2), ammonia, certain hydrofluoroolefins (HFOs), and other substitutes for HFCs with a GWP of 53 or below).[7] This includes:
    - Requiring annual leak inspection for all CR and IPR appliances containing 15 pounds up to 500 pounds of such refrigerant upon discovering the applicable leak rate

[6] EPA is exempting from the suite of leak repair requirements under subsection (h) any refrigerant-containing appliance used for the residential and light commercial air conditioning and heat pumps subsector.

[7] For brevity, unless otherwise stated, in this document we use the term "refrigerant" to include regulated HFCs and substitutes for HFCs with a GWP greater than 53.

threshold (20% per year and 30% per year for CR and IPR appliances, respectively) is exceeded.

  - Requiring annual leak inspection for all CC and other appliances containing 15 pounds of such refrigerant upon discovering the applicable leak rate threshold (10% per year) is exceeded.
  - Requiring quarterly leak inspection for all CR and IPR appliances that contain 500 pounds or more of such refrigerant upon discovering the applicable leak rate threshold is exceeded (unless ALD equipment meeting certain requirements is used for compliance).
  - Requiring repair of leaks and initial and follow-up verification tests on the repairs for all appliances containing 15 or more pounds of such refrigerant (i.e., CC, CR, and IPR) when the applicable leak rate threshold is exceeded.
  - Allowing owners/operators of all CC, CR, and IPR appliances containing 15 or more pounds of such refrigerant to request extensions to the leak repair and retrofit timeline.
  - Applying recordkeeping and reporting requirements associated with leak inspection and leak repair to appliances containing 15 pounds or more of such refrigerant.

- Use of ALD systems for CR and IPR appliances containing 1,500 pounds or more of a refrigerant for new appliances installed on or after January 1, 2026, and for existing appliances installed on or after January 1,2017, and before January 1, 2026, as of January 1, 2027.
- Use of reclaimed refrigerant as of January 1, 2029, for servicing and/or repair of refrigerant-containing equipment in the following RACHP subsectors: supermarket systems, refrigerated transport, and automatic commercial ice makers.
- For the servicing, repair, disposal, or installation of fire suppression equipment that contains HFC, the use of recycled HFCs for the servicing and/or repair of fire suppression equipment as of January 1, 2026, and use of recycled HFCs for the initial installation of fire suppression equipment as of January 1, 2030.
- Requiring as of January 1, 2028, that disposable cylinders that have been used for the servicing, repair, or installation of refrigerant-containing equipment be transported to an entity in the supply and disposal chain (e.g., a distributor, wholesaler, refrigerant repackager, an EPA-certified reclaimer, or a landfill or metal-recovery operator) and that such entities remove or ensure removal (e.g., by forwarding to an EPA-certified reclaimer) of all HFCs from disposable cylinders prior to discarding the cylinder.

- Requiring that disposable cylinders that have been used for the servicing, repair, or installation of fire suppression equipment be transported to a fire suppressant recycler and that fire suppressant recyclers remove all HFCs from disposable cylinders prior to discarding the cylinder.
- Finally, EPA is establishing alternative Resource Recovery and Conservation Act (RCRA) standards for ignitable spent refrigerants when recycled for reuse, as the term is to be defined under RCRA. EPA is stipulating that the 40 CFR part 266 Subpart Q RCRA alternative standards apply to HFCs and their substitutes that are lower flammability ignitable spent refrigerants.

1.3 Regulated Community

The HFC industry is composed of several types of entities. As noted in the RIA for the Allocation Framework Rule, entities potentially affected by this previous action include those that produce, import, export, destroy, use as a feedstock, reclaim, package, or otherwise distribute bulk HFCs. This analysis—which serves as an addendum to the above-mentioned Allocation Framework RIA—assesses a final rule under subsection (h) of the AIM Act that regulates certain practices, processes, or activities regarding the servicing, repair, disposal, or installation of equipment, for purposes of maximizing the reclamation and minimizing the release of HFCs from equipment and ensuring the safety of technicians and consumers. This rule affects certain entities who own, operate, service, repair, recycle, dispose, or install equipment containing HFCs or their substitutes, as well as those who recover, recycle, or reclaim HFCs or their substitutes. Manufacturers or sellers of equipment containing HFCs, or their substitutes may also be potentially affected. A detailed list of industries potentially affected by this rule can be found in Appendix H.

Chapter 2. Overview of the Analysis

2.1 Introduction

The purpose of this RIA addendum is to provide the public with information on the relevant costs and benefits of this action, as finalized, and to comply with executive orders. The document contains results of a costs and benefits assessment to help EPA and the public evaluate the impact of this final rulemaking across the affected businesses. Costs and benefits presented in this analysis include compliance costs (including recordkeeping and reporting costs), climate benefits, and combined net benefits.

Given that the rule establishes an emissions reduction and reclamation program for the management of HFCs, which are subject to previously finalized rulemakings under the AIM Act, EPA relied on previous analyses conducted for the Allocation Framework Rule (86 FR 55116; October 5, 2021), the 2024 Allocation Rule (88 FR 46836; July 20, 2023), and 2023 Technology Transitions Rule (88 FR 73098; October 24, 2023) as a starting point for the assessment of costs and benefits of this rule. We then evaluated how the provisions contained in this final rulemaking would yield potential incremental impacts.

In addition to a cost and benefits analysis, EPA conducted an environmental justice analysis evaluating facilities and surrounding communities that may be impacted by this rule. Following the analytical approach used in the Allocation Framework Rule RIA, the 2024 Allocation Rule RIA Addendum, and 2023 Technology Transitions Rule RIA Addendum, EPA has provided demographic data and the cancer and respiratory risks to surrounding communities.

2.2 Organization of the Analysis

The analysis contained in this document is organized as follows:

Chapter 3 summarizes key methodological assumptions relied upon for this analysis, including discussion of EPA's approach for evaluating incremental impacts relative to previous rulemakings and the marginal abatement cost (MAC) approach used for modeling the impact of regulatory requirements in this rule. Chapter 3 also summarizes assumptions and underlying data regarding the types of equipment affected by this rule. This includes equipment that relies on HFCs in the fire suppression, commercial refrigeration, industrial process refrigeration, and comfort cooling sectors. Using data from EPA's Vintaging Model, equipment is broken out by estimated average charge size (in pounds of refrigerant) and assumed leak rate.

Chapter 4 provides an assessment of the anticipated compliance costs resulting from the requirements contained in the final rule, including results from the MAC modeling approach. Estimated incremental costs are relative to those previously estimated by EPA for the Allocation and 2023 Technology Transitions Rules.

Chapter 5 provides an assessment of the anticipated environmental benefits resulting from the requirements contained in the final rule. As with results in chapter 4, estimated incremental benefits are relative to those previously estimated by EPA for the Allocation and 2023 Technology Transitions Rules. This chapter also provides details on the methodology used to calculate the social cost of HFCs (SC-HFCs).

Chapter 6 combines the compliance costs and climate benefit estimates from the preceding chapters to provide an assessment of total net benefits associated with the rule.

Chapter 7 covers the environmental justice analysis conducted for the rule. This analysis builds on the environmental justice analysis conducted for the Allocation and 2023 Technology Transitions Rules and evaluates the demographic characteristics and baseline exposure of the communities near facilities that reclaim HFCs.

Appendices A and B provide details on underlying data and assumptions used to estimate the costs and benefits of leak repair and inspection provisions contained in the final rule and the specific leak rate assumptions derived from EPA's Vintaging Model.

Appendix C provides detailed cost estimates by equipment category for the leak repair and inspection provisions contained in the final rule. These estimates were used to model abatement costs on a dollar-per-carbon dioxide equivalent (CO_2e)-ton basis for the MAC methodology.

Appendix D provides estimates of the servicing demand for equipment affected by reclamation provisions contained in the final rule, by HFC gas.

Appendix E provides additional details on assumptions made in order to model requirements contained in the final rule on a dollar-per-CO_2e-ton basis for the MAC methodology and a summary of mitigation options modeled and estimated costs.

Appendix F provides results under an alternative reference case scenario in which industry is assumed to undertake more leak repair and recovery activity in the reference case (i.e., in the absence of this rulemaking), thus illustrating a lower bound of the potential incremental benefits of this rule.

Appendix G provides a Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996 analysis of estimated impact to small entities, including small businesses and small governments, associated with establishing the leak repair and inspection provisions and ALD requirements to HFC and substitutes for HFCs.

Appendix H lists the industries that might be affected by this rule.

Appendix I provides annual SC-HFC estimates used to estimate the climate benefits of this rule. These values are consistent with the SC-HFC estimates used in the proposal RIA and in previous analysis conducted for the Allocation and 2023 Technology Transitions Rules.

Appendix J provides estimated climate benefits of this rule using updated SC-HFC estimates. These values were calculated following the methodology set forth in the *EPA Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances.*

Appendix K provides a sensitivity analysis based on the assumed cost of reclaimed refrigerant vis a vis virgin refrigerant.

Appendix L provides a sensitivity analysis based on alternative ALD installation requirements considered for the final rule.

Appendix M provides additional details on the evaluation of potential costs and benefits of the requirement that disposable cylinders that contain HFCs and that have been used in the service, repair or installation of refrigerant-containing equipment be sent to an EPA-certified reclaimer or another final processor in the supply chain, as well as sensitivity analyses related to these costs and benefits.

2.3 Years of Analysis

This analysis estimates the costs and benefits of compliance with provisions contained in the final rule. The earliest required compliance year is 2026, and—consistent with prior analyses conducted for the Allocation and 2023 Technology Transitions Rules—EPA has evaluated cumulative costs and benefits through the year 2050. For the purposes of this analysis, we have assumed that full compliance will be reached for each provision contained in the final rule by the first year in which the requirement starts, and that compliance continues through 2050 (the final year included in this analysis).

2.4 Factors Analyzed

This RIA addendum takes into consideration the compliance costs of meeting the requirements of this rule as finalized as well as the associated the environmental benefits of the consequent reduction in HFC emissions and the associated avoided global warming. Consistent with the Allocation Rules RIA and the 2023 Technology Transitions RIA Addendum, specific factors evaluated in this assessment include capital costs, operations and maintenance (O&M) costs, recordkeeping and reporting costs, anticipated refrigerant savings (e.g., from early leak detection and repair and heel recovery), and benefits resulting from the avoided release of HFCs into the atmosphere. This analysis does not consider certain factors that could potentially further reduce compliance costs, such as potential decreases in costs over time resulting from economies of scale or the energy savings from reduced cooling demand as a result of avoided global warming.

2.5 Vintaging Model

EPA uses the Vintaging Model to forecast the use and emissions of HFCs and other substances, by sector and subsector, under a business as usual (BAU) scenario and under various policy compliance scenarios. This analysis uses a version of the model intended to represent compliance with the AIM Act HFC Phasedown and 2023 Technology Transitions Rule as a starting point and makes adjustments to various subsectors of affected equipment and end uses as needed to align with the requirements of the final ER&R rule. The resulting consumption and emissions are compared against the analysis developed for the Allocation and 2023 Technology Transitions Rules to evaluate incremental impacts.

The model tracks the use and emissions of regulated substances separately for each generation or "vintage" of equipment. The Vintaging Model is used to produce the estimates of GHG emissions in the official U.S. GHG Inventory and is updated and enhanced annually. Information on the version of the model used for this analysis, the various assumptions used, and HFC emissions may be found in EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2014. A more detailed explanation of the Vintaging Model is also found in Section 3.2.1 of the Allocation Framework RIA.

2.6 Regulatory Option

The primary costs/benefits analysis conducted for this RIA addendum is based on the estimated compliance costs and benefits of the requirements contained in the final rule. In our analysis of the proposed rule, we investigated the potential costs and benefits of alternative regulatory scenarios, including alternative equipment charge size threshold for the leak repair requirements. In this updated RIA Addendum for the final ER&R rule, EPA is providing additional costs and benefits scenarios for alternative options considered for the final rule. These include:

- Alternative cutoff years for the final rule's ALD installation requirements for existing equipment, including scenarios where the requirements would have covered systems installed within 5 years of the compliance deadline or where the requirements would have covered all existing equipment (i.e., no cutoff date). See Appendix M for these results.

- Alternative compliance start years for the rule's provisions related to the management of disposable cylinders. See Appendix N for these results.

Importantly, the statutory direction for this final rule is not dependent on the analysis of costs and benefits, but rather the rule is designed to serve the purposes identified in subsection (h) of the Act of "maximizing reclaiming and minimizing the release of a regulated substance from equipment and ensuring the safety of technicians and consumers." We refer the reader to the final rule for further explanation of the requirements finalized therein.

2.7 Uncertainty

Throughout this RIA Addendum, EPA has included a number of sensitivity analyses on particular modeling parameters and assumptions relied upon for this analysis. These include:

- Assumed cost of reclaimed HFCs vis-a-vis virgin manufactured HFCs (see Appendix K)
- Assumed industry behavior including improvements to leak repair and recovery that would occur in the reference case for this analysis (i.e., in the absence of this rulemaking) and resulting incremental benefits (see Appendix F)
- The number of disposable refrigerant cylinders in circulation in the United States, the average volume of heel gas remaining in disposable cylinders, and the average rate of venting of heel gas versus removal (see Appendix M)

Uncertainty regarding the social cost of HFC (SC-HFC) methodology utilized in this RIA Addendum is also discussed in Chapter 5.

Chapter 3. Methodology

3.1 Reference Case and Relationship to Prior Analyses

Background

Through the Allocation Framework Rule (86 FR 55116, October 5, 2021) as well as an update to that rule, 2024 Allocation Rule (88 FR 46836, July 20, 2023), EPA has established a consumption baseline for the phasedown of HFCs.[8] The consumption baseline was established using the average annual quantity of all regulated substances consumed in the United States from January 1, 2011, through December 31, 2013, and additional quantities of past chlorofluorocarbon (CFC) and hydrochlorofluorocarbon (HCFC) consumption. More details on the methodology used to establish this baseline can be found in the Allocation Framework Rule.[9] The baseline serves as the starting point from which statutorily mandated percentage reductions are taken to implement the AIM Act HFC phasedown.

Following the finalization of these rules, EPA furthered the implementation of the AIM Act by finalizing the 2023 Technology Transitions Rule (88 FR 73098, October 24, 2023). The rule includes restrictions on the use of certain hydrofluorocarbons (HFCs) above a certain global warming potential (GWP) whether neat or used in a blend, and restrictions on certain HFCs and certain blends containing HFCs, in specific sectors or subsectors where HFCs are used.

EPA has previously estimated costs and benefits of the HFC phasedown, which are detailed in the Allocation Framework RIA and 2024 Allocation Rule RIA Addendum, and for the 2023 Technology Transitions Rule, which are updated in the 2023 Technology Transitions Rule RIA Addendum. The final ER&R Rule focuses on statutory provisions under the AIM Act that are separate from those addressed in the Allocation Rules and 2023 Technology Transitions Rule. However, in order to avoid double counting or overestimating of costs and benefits of this rule, for the purposes of this analysis the estimated economic and environmental impacts of these prior rules are assumed to be the status quo or "reference case"[10] from which incremental impacts may be calculated.

As detailed in the Allocation Framework Rule RIA, 2024 Allocation Rule RIA Addendum, and 2023 Technology Transitions Rule RIA Addendum, EPA relied upon a MACC approach in order to estimate the full set of industry transitions and associated compliance costs required to meet statutory

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[8] The shorthand "Allocation Rules" is used throughout this document to refer to these rules together.

[9] *https://www.federalregister.gov/documents/2021/10/05/2021-21030/phasedown-of-hydrofluorocarbons-establishing-the-allowance-allocation-and-trading-program-under-the*.

[10] As a disambiguation, throughout this document we refer to the Allocation and 2023 Technology Transitions Rules estimates as the "reference case" rather than "baseline," to avoid confusion with the statutory baseline for the Allocation Rules.

requirements. Emissions benefits were estimated based on the difference between HFC emissions in the compliance pathway and HFC emissions under a BAU scenario without the statutory requirements in place. Analysis for this rule builds on this previously used methodology by adding on additional measures required by the final ER&R rule and evaluating their incremental impact.

HFC Consumption under BAU and Reference Case Projection

Under the previously modeled compliance pathways for the Allocation and 2023 Technology Transitions Rules, HFC consumption and emissions over time for appliances across all major sectors (including fire suppression, CC, IPR, and CR) are significantly lower (in CO2e terms) than they otherwise would be under a BAU scenario. Since this analysis assumes these transitions and improved service activities occur in the reference case, the estimated avoided emissions from some of the provisions contained in this final rule are less than what they would be if a BAU scenario were used that does not assume these transitions and improved service activities occur.

Table 3-1 below shows the consumption-based BAU originally used to quantify benefits in the Allocation Rule analyses, as well as estimated consumption under the reference case used for this analysis that also incorporates impacts from the 2023 Technology Transitions Rule. The latter is used to quantify incremental benefits in this analysis.

Table 3-1- *HFC Consumption under original BAU and reference case (MMTEVe)*[11]

Year	*HFC Consumption under BAU (i.e., no AIM Act)*	*HFC Consumption under ER&R rule reference case (i.e., with Allocation and 2023 Technology Transitions Rules)*
2025	315	126
2030	317	60
2035	324	16
2040	337	27
2045	352	30
2050	366	33

[11] In this document, units for consumption and emission reductions are presented in Million Metric Tons Exchange Value Equivalent (MMTEVe) or Metric Tons Exchange Value Equivalent (MTEVe). As explained in the Allocation Framework Rule, a metric ton of exchange value equivalent (MTEVe) is numerically equal to a metric ton of carbon dioxide equivalent ($MTCO_2e$) and we use these terms interchangeably throughout this document.

Approach for Estimating Incremental Impacts

Results from this analysis indicate that the final ER&R rule will yield incremental HFC consumption and emissions reductions relative to the previously modeled compliance pathways.[12] However, the extent of these incremental benefits depends in part on whether some of the HFC consumption- and emissions-reducing activities required by this final rule (such as improvements to detect and repair leaks) would have already been undertaken by industry in order to comply with, or otherwise address market outcomes from, the Allocation and 2023 Technology Transitions Rules.

As detailed in the 2023 Technology Transitions RIA Addendum, the precise set of transitions that will be undertaken by industry to meet compliance is uncertain, leading to a range in potential incremental benefits. The 2023 Technology Transitions RIA Addendum included two primary compliance scenarios illustrating this uncertainty:

> a) a base case scenario where compliance options not explicitly required by the rule but envisioned under the Allocation Rules were excluded, thus yielding benefits (i.e., greater reductions in HFC consumption and emissions) for certain subsectors but also disbenefits (i.e., lower reductions in HFC consumption and emissions) for other subsectors, relative to the Allocation Rule results.
>
> b) an upper-bound scenario of incremental benefits where compliance options from the Allocation Rules were assumed to occur even though not explicitly required by the 2023 Technology Transitions Rule, including actions taken in the fire protection subsector, improved leak repair, and additional recovery at disposal.

To evaluate the incremental impacts of the ER&R rule relative to the policy status quo, the former, base case scenario from the 2023 Technology Transitions RIA Addendum is used as the primary reference case from which additional costs and benefits are evaluated in this analysis. In this way, all measures found to be required to meet compliance with the Allocation and 2023 Technology Transitions Rules, based EPA's prior analyses, are assumed to occur in the reference case. Additional measures from the above-mentioned upper-bound scenario, which are not required to meet compliance with the

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[12] However, the schedule for the production and consumption phasedown is not made more stringent than the schedule under subsection (e)(2)(C) of the AIM Act (i.e., the production and consumption caps contained in the Allocation Rules are unchanged).

Allocation and 2023 Technology Transitions rules (namely, enhanced recovery, leak repair, and transitions in the fire protection sector), are not assumed to occur in the reference case.

Given the uncertainty regarding whether industry may undertake these measures in the absence of explicit requirements, in Appendix F EPA has also provided an alternative scenario where we assume that the above-mentioned improvements to leak repair and recovery would occur even in the absence of this rule and they are therefore included in the reference case. This alternative scenario effectively illustrates a lower-bound of the incremental benefits of the final ER&R rule.

EPA notes that the above assumptions are made for technical analytic purposes and to avoid double counting of benefits. They should not be interpreted as a reflection of the merits of any particular provision contained in the final rule.

Moreover, there are likely additional significant benefits associated with provisions contained in the final rule that are not quantified in the incremental benefits presented in this document. These include, but are not limited to:

- the life-cycle cost savings associated with the use of reclaimed HFCs and substitutes for HFCs as opposed to virgin HFCs and substitutes for HFCs;
- the moderation of future spikes in the cost of HFCs due to increased availability of reclaimed HFCs;
- avoidance of stranded equipment in later years when, if the market were reliant on virgin HFCs, equipment could be mothballed or prematurely retired due to HFC scarcity and shortages;
- the freeing up of available virgin HFCs for applications where reclaimed HFCs have not been proven effective for use; and
- avoided supply shortages of HFCs that are still needed for servicing certain appliances, by maximizing the supply of reclaimed refrigerant, thus protecting the cold chain needed to deliver food and vaccines.

3.2 Equipment Characterization

In order to evaluate costs and benefits, EPA relied on the Vintaging Model (described in section 2.5 above) to construct an inventory of equipment and appliances potentially affected by specific provisions contained in the final rule as well as associated use and disposition of regulated substances over time. This section provides a description of assumptions made to determine the universe of equipment and appliances affected. Qualitative descriptions of the broad categories of affected equipment and appliances are also provided.

Equipment in the Fire Suppression Sector

Fire suppression equipment covered by this final rule fall into two categories, and both types of equipment may contain HFCs that would be discharged in the event of a fire. Total flooding systems are designed to automatically discharge a fire extinguishing agent by detection and related controls (or manually by a system operator) and achieve a specified minimum agent concentration throughout a confined space (i.e., volume percent of the agent in air) that is sufficient to suppress development of a fire. Streaming applications use portable fire extinguishers that can be manually manipulated to discharge an agent in a specific direction and release a specific quantity of extinguishing agent at the fire. Table 3-2 summarizes reference case stock and emissions in 2025 for both end-uses within the Fire Suppression sector.

Table 3-2. Estimated Installed Stock (MT) and Emissions (MT) by Equipment Type (2025)

Equipment Type	*Installed Stock (MT)*	*% of Total Installed Stock*	*Leak Emissions (MT)*	*% of Total Leak Emissions*
Total Flooding Systems	12,861	87%	322	83%
Streaming Units	1,872	13%	66	17%
Total	**14,733**		**387**	

Refrigeration and Comfort Cooling Appliances

A variety of Refrigeration, Air Conditioning, and Heat Pump (RACHP) appliances used in the United States contain refrigerants, and these appliances can be organized into charge size groups such as the following: 1) appliances containing five or fewer pounds of a refrigerant containing an HFC or substitute for an HFC, 2) appliances containing between five and 15 pounds of such refrigerant, and 3) appliances containing more than 15 pounds of such refrigerant. For this analysis, affected equipment is considered to be refrigeration and AC appliances containing 15 pounds or more of a refrigerant containing an HFC or substitute for an HFC with a GWP greater than 53.[13]

Figure 3-1 shows the projected installed stock of HFC refrigerant by RACHP appliance type across all equipment sizes in the United States in 2025, as modeled in EPA's Vintaging Model (EPA 2023f)[14] and Figure 3-2 shows estimated annual leak emissions (exclusive of loss during disposal) by appliance

[13] For brevity, unless otherwise stated, in this document we use the term "refrigerant" to include regulated HFCs and substitutes for HFCs with a GWP greater than 53.
[14] As explained in the RIA to the Allocation Framework Rule and associated addenda to that RIA, the Vintaging Model estimates the consumption and emissions from subsectors that traditionally relied on ODS and are transitioning to HFCs and other alternatives. The EPA 2023f version of the model (VM IO file_v4.4_02.04.16_Final TT Rule 2023 High Addition.xls) incorporates the transitions and practices anticipated to occur under the 2023 Technology Transitions RIA Addendum High Additionality Case, which in turn incorporates provisions of that rule and other actions anticipated under the 2024 Allocation Rule not otherwise adjusted based on the 2023 Technology Transitions Rule.

type in 2025. These appliances contain approximately 1.0 million MT (2.1 billion pounds) of HFC refrigerant and are estimated to release approximately 62,000 MT (140 million pounds) of HFC refrigerant in 2025 (an aggregate average leak rate of 6.2%) in the absence of control measures required by this rule. Table 3-3 summarizes stock and leak emissions in 2025 for each appliance type.

Figure 3-1 – Projected Installed Stock (MT) of HFC Refrigerant by RACHP Appliance Type and Charge Size (2025)

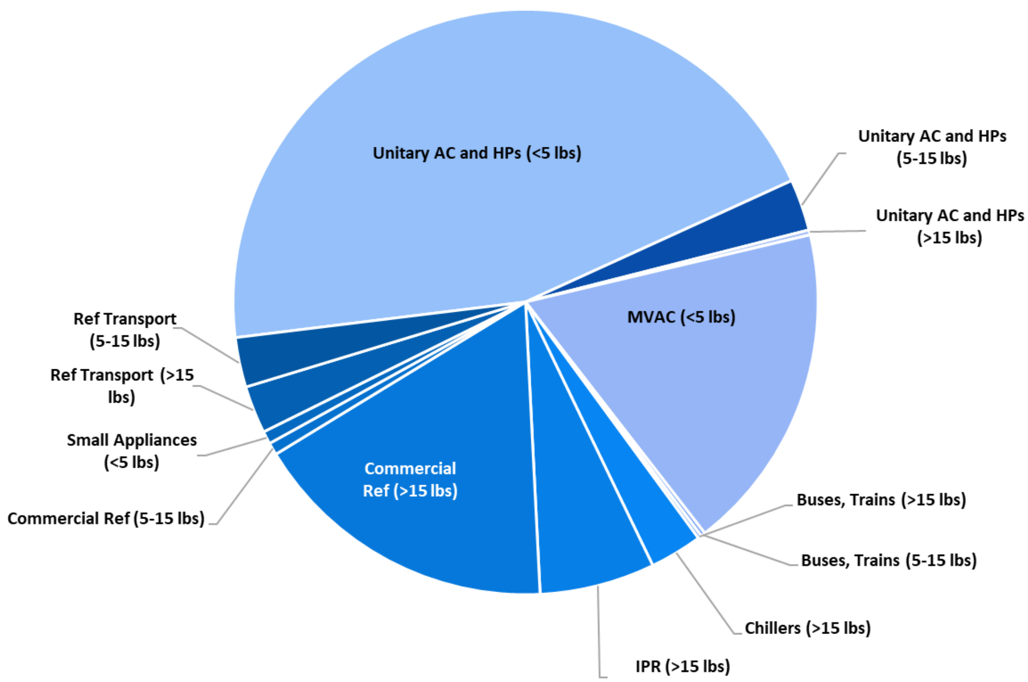

Figure 3-2 – Estimated Leak Emissions (MT) of HFC Refrigerant by RACHP Appliance Type and Charge Size (2025)

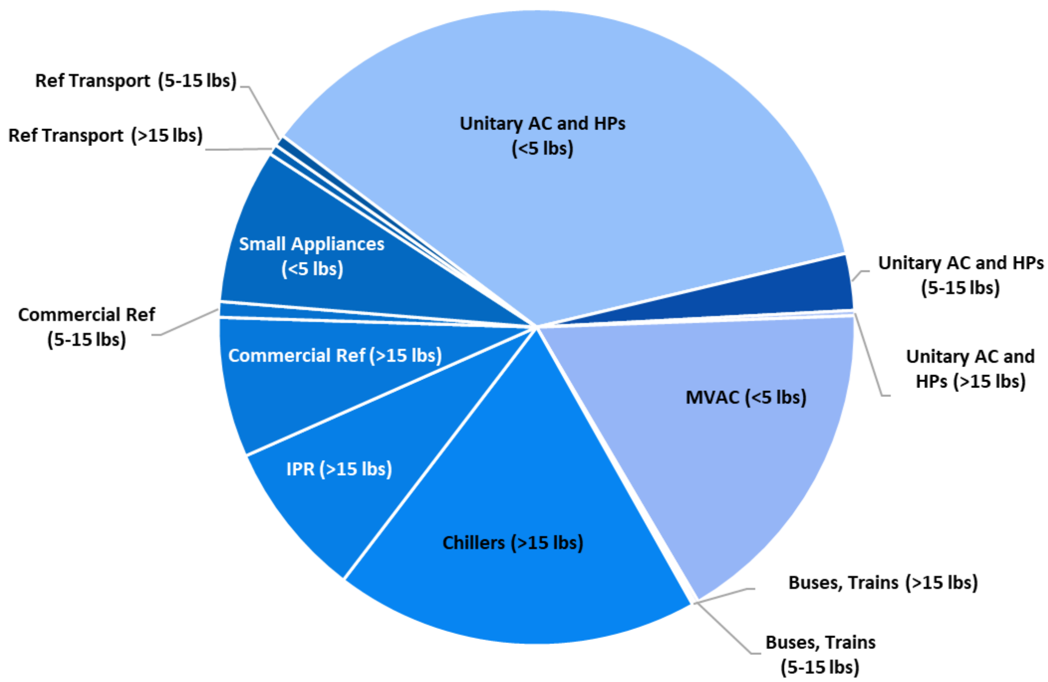

Table 3-3. Estimated Installed Stock (MT) and Leak Emissions (MT) by Equipment Type (2025)

Equipment Type	***Installed Stock (MT)***	***% of Total Installed Stock***	***Leak Emissions (MT)***	***% of Total Leak Emissions***
MVAC (<5 lbs)	165,600	17%	11,300	18%
Unitary AC and HPs (<5 lbs)	348,400	36%	28,000	45%
Small Appliances (<5 lbs)	76,400	8%	400	0.6%
<5 lbs total	**590,400**		**39,700**	
Buses, Trains (5-15 lbs)	1,600	0.2%	200	0.3%
Ref Transport (5-15 lbs)	5,600	1%	1,700	3%
Commercial Ref (5-15 lbs)	7,700	1%	400	1%
Unitary AC and HPs (5-15 lbs)	27,900	3%	1,800	3%
5-15 lbs total	**42,800**		**4,100**	
Buses, Trains (>15 lbs)	1,500	0.2%	100	0.2%
Chillers (>15 lbs)	179,400	19%	1,800	3%
IPR (>15 lbs)	77,300	8%	3,900	6%
Commercial Ref (>15 lbs)	69,000	7%	10,600	17%
Ref Transport (>15 lbs)	5,000	1%	1,600	3%
Unitary AC and HPs (>15 lbs)	2,700	0.3%	200	0.3%
>15 lbs Total	**334,900**		**18,200**	
Total	**968,100**		**62,000**	

The ER&R rule covers three broad categories of RACHP appliances, which can be summarized as follows:

- **Commercial refrigeration (CR)** equipment are the refrigerant-containing appliances used in the retail food and cold storage warehouse sectors and refrigerated transport systems. Retail food appliances include the refrigeration equipment found in supermarkets, convenience stores, restaurants, and other food service establishments and include multiplex rack systems and condensing unit systems. Cold storage appliances include the equipment used to store meat, produce, dairy products, and other perishable goods. Refrigerated transport appliances include the equipment to move perishable goods (e.g., food) and pharmaceutical products by various modes of transportation, including rail and ships.
- **Industrial Process Refrigeration (IPR)** equipment are complex, customized refrigerant-containing appliances used in the chemical, pharmaceutical, petrochemical, and manufacturing industries. These appliances are directly linked to the industrial process. This sector also includes industrial ice machines, refrigerant-containing appliances used directly in the generation of electricity, and ice rinks.
- **Comfort Cooling (CC)** equipment includes stationary refrigerant-containing appliances that provide cooling in order to control temperature and/or humidity in occupied facilities, such as office buildings and commercial buildings, and mobile AC equipment. Comfort cooling appliances include building chillers (which can be further broken down by compressor type) and mobile AC for transit, school, and tour buses and passenger trains.

Additional description of the Vintaging Model end-uses within each sector and equipment category is provided in Appendix A.

Equipment Affected by Leak Repair and Inspection Provisions

The leak repair and inspection provisions contained in the final rule affect refrigerant-containing appliances with a charge size (i.e., amount of refrigerant in a given independent circuit) of 15 pounds or more. CR, CC, and IPR appliances containing 15 pounds or more of HFC refrigerant[15] were identified using EPA's Vintaging Model, which models equipment using average charge sizes. To provide

[15] Although the final rule also covers substitutes for an HFC, this analysis focuses on HFCs and HFC-containing blends, including HFC-containing substitutes, noting that most other HFC substitutes modeled have small to zero GWPs (e.g., hydrocarbons, hydrofluoroolefins, carbon dioxide, and ammonia).

additional variation in potential costs and benefits for larger refrigerant-containing appliances where a more significant range of possible charge sizes is likely such that at least some portion of the appliances are addressed by this rule, end-uses were distributed into "low" (i.e., 50 percent of the modeled average charge size), "average" (i.e., the modeled average charge size), and "high" (i.e., 150 percent of the modeled average charge size) groups. Each group was assigned one-third of the total units, and the charge size distributions equal the weighted average charge size modeled in the Vintaging Model. Each end-use/charge size group was then categorized as sub-small (containing between 15 and 50 pounds of refrigerant), small (containing between 51 and 199 pounds of refrigerant), medium (containing between 200 and 1,999 pounds of refrigerant), and large (containing greater than 2,000 pounds of refrigerant). The categorization is done because provisions in the rule vary by charge size. Table 3-3 provides a mapping of end-uses into these three charge size groups and categorization. A more detailed version showing each end-use separately is available in Appendix A.

Table 3-4: Apportionment of Appliance Types by Refrigerant Charge Size

Appliance Sector	***Appliance Type [a,b]***	***Average Charge Size (lbs) [c]***	***Distributed Charge Size Group***	***Charge Size Analyzed (lbs)***	***Equipment Size***
Comfort Cooling	School & Tour Bus AC	13	Low	5	N/A
			Average	11	N/A
			High	16	Sub-small
	Transit Bus AC	16	Low	8	N/A
			Average	16	Sub-small
			High	24	Sub-small
	Passenger Train AC	41	Low	20	Sub-small
			Average	41	Sub-small
			High	61	Small
	Chillers	1,105	Low	265 – 929	Medium
			Average	529 – 1,857	Medium
			High	794 – 2,786	Medium – Large
Commercial Refrigeration	Modern Rail Transport	17	Low	8	N/A
			Average	17	Sub-small
			High	25	Sub-small
	Vintage Rail Transport	33	Low	17	Sub-small
			Average	33	Sub-small
			High	50	Sub-small
	Condensing Unit	47	Low	23	Sub-small
			Average	47	Sub-small
			High	70	Small
	Marine Transport	1,021	Low	194 – 827	Small – Medium
			Average	388 – 1,653	Medium
			High	582 – 2,480	Medium – Large

	Rack	2,038	Low	1,019	Medium
			Average	2,038	Large
			High	3,057	Large
	Cold Storage	24,755	Low	12,110 – 12,716	Large
			Average	24,220 – 25,431	Large
			High	36,331 – 38,147	Large
Industrial Process Refrigeration	IPR	6,633	Low	972 – 7,939	Medium – Large
			Average	1,945 – 15,877	Medium – Large
			High	2,917 – 23,816	Large

[a] Only end-uses within appliance sectors CC, CR, and IPR are shown.
[b] End-uses with charge sizes less than 10 pounds are not shown as even under the "high" charge size group, they will not be affected by the leak inspection and repair provisions of the rule.
[c] For some appliance types, the Vintaging Model simulates multiple subsectors that are distinguished by size, original ozone-depleting substances (ODS) refrigerant type, or technology. In those cases, a range is provided.

Refrigerant-containing appliances with a charge size greater than or equal to 15 pounds must also exceed specified annual leak thresholds to trigger the leak repair and inspection requirements contained in the final rule, and CR and IPR appliances with refrigerant charge sizes of 1,500 pounds or more must use an ALD system.[16] The proportion of refrigerant-containing appliances above the applicable leak rate thresholds was based on appliance stock estimated in the Vintaging Model. Because the Vintaging Model models appliances using average leak rates,[17] appliance stock was distributed into quintiles, each containing 20 percent of units, where the leak rate distributions equal the weighted average leak rate modeled in the Vintaging Model for each appliance type. Based on this approach, it is assumed that each subsector has at least 20 percent of its stock (i.e., one quintile) above the threshold leak rate. By distributing leak rates in this way, we estimate the percentage of each end-use that leaks above the threshold rates under which actions are required by this rule.[18] As an example, Transit Bus AC has an average leak rate of 10% per year. We divide the end-use into five quintiles, with annual leak rates of 5%,

[16] Owners and operators of refrigerant-containing appliances that are not required to install an ALD system (e.g., those with a charge size of less than 1,500 pounds) may voluntarily choose to install an ALD system as a compliance option for leak repair requirements in lieu of the applicable requirements for periodic leak inspections and certain recordkeeping and reporting requirements. However, leak inspections are required to be performed for the portions of the appliance where the ALD system is not monitoring for leaks.
[17] Under the base case scenario in this document, for chillers, large retail food (rack systems), cold storage, and industrial process refrigeration systems, the leak rate distributions were applied to the average leak rate modeled in the Vintaging Model as of 2026 with a 40 percent leak rate reduction, which is consistent with the assumption that larger refrigeration and AC equipment will experience enhanced leak recovery under the 2024 Allocation Rule as explained in the RIA to the Allocation Framework Rule and associated addenda to that RIA.
[18] The threshold leak rates are the same as those established under 40 CFR, part 82, subpart F; namely, 30% per year for CR appliances, 20% per year for IPR appliances, and 10% per year for CC and all other refrigerant-containing appliances.

7.5%, 10%, 12.5%, and 15%. Therefore, we calculate that 40% of the appliances (those in the last two quintiles), exceed the threshold leak rate of 10% per year, See Appendix B for more detail.

Table 3-5 presents the assumptions made for this analysis regarding the proportion of affected refrigerant-containing appliances experiencing leaks above the threshold.

Table 3-5: Affected Refrigerant-Containing Appliance Assumptions by Appliance Sector, Type, and Size

Appliance Sector	***Appliance Type***	***Appliance Size***	***Average Charge Size (lbs)***[a]	***Percentage of Appliances Experiencing Leaks Above the Threshold Rate***
Comfort Cooling	School & Tour Bus AC[b]	Sub-small	16	13%
	Transit Bus AC	Sub-small	16	40%
	Passenger Train AC	Sub-small	41	20%
	Chiller	Medium	265 – 1,985	20%
		Large	2,084 – 2,786	20%
Commercial Refrigeration	Modern Rail Transport[c]	Sub-small	17	80%
	Vintage Rail Transport[c]	Sub-small	33	80%
	Condensing Unit	Sub-small	47	20%
	Marine Transport	Small	194	80%
		Medium	388 – 1,653	60% – 80%
		Large	2,480	60%
	Rack	Medium	986–1,972	20%
		Large	2,959	20%
	Cold Storage	Large	10,655 – 38,147	20%
Industrial Process Refrigeration	IPR	Medium	1,049 – 1,059	20%
		Large	2,099 – 23,816	20%

[a] For some equipment types, the Vintaging Model models multiple subsectors which are distinguished by size, original ozone-depleting substances (ODS) refrigerant type, or technology. In those cases, a range is provided.
[b] 66 percent of School & Tour Bus AC units have charge sizes below the charge size threshold of 15 lbs. and therefore are not included as affected appliances (EPA 2023f).
[c] The Vintaging Model models two subsectors for refrigerated rail car transport: vintage and modern. Modern rail refrigeration systems are considered to be easily replaceable units previously developed for road transport and adapted for rail use, have a lifetime of approximately 9 years, and a refrigerant charge size less than 20 pounds. Older or vintage units were typically developed specifically for rail use and operate for the whole lifetime of the railcar itself (i.e., 40 years) and have larger charge sizes than modern systems (EPA 2023f).

Equipment Affected by the Automatic Leak Detection Provisions

Refrigerant-containing appliances within the CC and IPR sectors are required to install an ALD system if the normal charge size is equal to 1,500 pounds or more. Some refrigerant-containing appliances are assumed to already have an ALD system installed. For instance, some refrigerant-containing appliances are provided with an ALD system, or have an option to include such. In this analysis, we assume 10 percent of affected refrigerant-containing appliances already have an ALD system installed in the reference case, and hence do not yield costs or benefits based on this rule.

In addition, the State of California requires the use of an ALD system if the refrigerant charge size exceeds 2,000 pounds. Using population as a proxy, we assume 12 percent of appliances with refrigerant charge sizes exceeding 2,000 pounds have an ALD system installed, in addition to the 10 percent reference case assumption. Combining these, and assuming a portion of the 10 percent reference case is in California, we estimate that 20.8 percent of appliances with refrigerant charge sizes over 2,000 pounds already have an ALD system installed.

For appliances between 1,500 and 2,000 pounds of refrigerant, we assume that an additional seven percent of affected appliances will already have an ALD system installed. This is the approximate percent of supermarkets represented under EPA's GreenChill voluntary program. As above, combining these two factors yields the assumption that 16.3 percent of affected appliances with refrigerant charge sizes between 1,500 and 2,000 pounds already have an ALD system installed.

Equipment Affected by Reclamation Provisions

The final ER&R rule also requires the use of reclaimed refrigerant to service and/or repair existing refrigerant-containing equipment in specific RACHP subsectors. Refrigerant-containing equipment in the supermarket systems, refrigerated transport, and automatic commercial ice makers subsectors must use reclaimed refrigerants containing HFCs when refrigerant containing HFCs is needed to service and/or the equipment. The universe of refrigerant-containing equipment affected by these provisions and corresponding refrigerant demand was estimated using EPA's Vintaging Model (EPA 2023f). In 2029 (the first compliance year for these provisions), accounting for the leak repair provisions in the final rule, total reclaimed refrigerant demand is estimated to be approximately 12,168 MT as shown in Table 3-6 below. Note that these totals only reflect the AIM-listed HFCs, including those that are incorporated in blends; for example, HFOs, whether neat or in a blend with HFCs, are not included because the requirement to use reclaimed refrigerants for service applies only to the regulated HFCs.

Appendix D provides additional, detailed tables showing estimated servicing demand by specific HFC gas for refrigerant-containing equipment affected by these provisions.

Table 3-6 Service Demand of HFCs for Applicable RACHP Subsectors in 2029

Subsector	Refrigerant-Containing Equipment Type	Service Demand (MT)
Supermarket Systems		8,660
Refrigerated Transport	Road	1,405
	Vintage	10
	Modern Rail	9
	Intermodal Containers	304
	Marine	1,705
Automatic Commercial Ice Makers		75
Total		**12,168**

Reclamation of HFCs and refrigerants in general has been practiced for many years. While the required use of reclaim to service the above-listed subsectors may direct more reclaimed refrigerant thereto, it is likely that reclaimed refrigerants, to the extent available, will still be used in other subsectors. Recently reported total annual reclaim levels (3,450 MT in 2022) fall short of the above estimated demand for 2029, indicating that industry would have to make strides to increase reclamation totals in the coming years. This can be expected and has been seen in past refrigerant phaseouts. For instance, production of HCFC-22 for service ceased in 2020, yet numerous equipment continues to operate and continues to be serviced with reclaimed HCFC-22. Indeed, HCFC-22 has been the substance reclaimed the most (by mass) since at least the year 2000 (EPA, 2023e). To provide a perspective on recent reclaimed HFC levels, Table 3-7 below displays the amount of reclaim, in MT and million MT of CO_2e ($MMTCO_2e$), compared to consumption.

Table 3-7: Summary of HFC reclaim and consumption

Year	Reclaimed HFCs (MT)[a]	Reclaimed HFCs ($MMTCO_2e$)[a]	Consumption ($MMTCO_2e$)[b]
2017	2,309	4.9	290
2018	2,382	5.1	306
2019	2,749	5.5	314
2020	2,445	5.0	309
2021	2,455	5.0	462
2022	3,450	7.2	253

[a] (EPA, 2024d)
[b] Years 2017-2021 from EPA's Greenhouse Gas Reporting Program (EPA, 2024b); 2022 from EPA's HFC Data Hub (EPA, 2024c).

These data indicate that there remains a wide gap between consumption of virgin regulated substances versus the amount that is reclaimed each year (a ratio of over 40 to 1 in 2022), and that significant increases in recovery and reclamation rates are possible. According to estimates from EPA's Vintaging Model, the amount of HFCs available for recovery at disposal (i.e., as equipment reaches the end of its useful life) in the coming years significantly exceeds the amount of demand from the subsectors required by the rule to use reclaimed refrigerant and shown in Table 3-6 above.

Reference case rates of recovery at disposal are derived from EPA's vintaging model BAU and correspond to equipment end-of-life loss rates of 5 to 65 percent of remaining refrigerant depending on equipment type.[19] At these rates, EPA estimates total annual recovery of HFCs from refrigerant-containing equipment of 35,458 MT in 2029, or almost three times the demand required by the final ER&R rule's servicing reclaim provisions, and well more than three times if 15 percent of the demand for reclaim shown above were met with virgin HFCs. Table 3-8 below provides assumed recovery and demand for HFCs estimated to be necessary to meet servicing requirements in 2029.

Table 3-8 – *Modeled Recovery and Service Demand for HFCs in 2029 (RACHP only)*

Gas	Estimated Reference Case Recovery in 2029 (MT)	Estimated Demand Resulting from ER&R Servicing Reclaim Provisions in 2029 (MT)	Estimated Demand Resulting from ER&R Servicing Reclaim Provisions in 2029 - 85% (MT)[a,b]
HFC-125	11,153	5,110	4,344
HFC-134a	13,376	3,381	2,874
HFC-143a	1,700	2,259	1,920
HFC-32	9,229	1,417	1,204

[a] Assumes 15% of reclaim demand will be met with virgin HFCs, consistent with regulatory requirements, thus reducing overall required demand for reclaimed HFCs.
[b] For blends, the assumed 15% reduction in demand shown in this table is applied proportionally across constituent HFCs. However, actual mix of virgin versus reclaimed of HFCs may vary. For example, a hypothetical 15/85 blend of HFC-143a and HFC-125 could comprise entirely virgin HFC-143a (a gas with shorter supply of estimated recovery in the above table), so long as the HFC-125 share (a gas with greater supply of estimated recovery in the above table) came entirely from reclaimed HFCs.

The values in Table 3-8 do not take into account industry's ability to leverage existing stocks and inventory of reclaimed material (provided they conform with the rule's requirement), which are likely to contribute to meeting the requirements of the rule, since reclaimed HFCs used to meet the requirements of the rule may have been recovered in prior years. In addition, the above values are inclusive of recovery and demand of specific blends, broken out by constituent HFCs. For example, a large share of the estimated recovery of HFC-125 and HFC-32 shown in Table 3-8 is driven by modeled recovery of R-410A (a 50/50 by weight blend of these two gases). These gases may then presumably be available to meet demand for blends such as R-452B (11% HFC-32 and 59% HFC-125), which drives a significant share of the estimated demand for these gases in Table 3-8. These dynamics may also indicate a need for

[19] The Vintaging Model assumes disposal recovery from equipment reaching end-of-life in a particular year is recovered and used, possibly after reclamation, to meet consumption demand for the same subsector and substance (i.e., new chemical demand plus servicing demand) in the same year.

continued industry capacity to reconstitute the component HFCs of recovered blends as demand changes in response to the 2023 Technology Transitions and ER&R Rules.

3.3 Marginal Abatement Cost Model

To generate cost estimates for the leak repair and inspection, fire suppression, and reclamation requirements of the final ER&R rule, EPA relied on a marginal abatement cost (MAC) methodology consistent with the approach used in the Allocation Framework RIA (see Section 3.2 of the Allocation Framework RIA) and the 2023 Technology Transitions RIA Addendum. As before, consumption- and emissions-reducing measures that meet compliance with the rule were modeled in terms of their costs on a dollars-per-ton of CO2e avoided basis and added to an integrated MAC curve of abatement measures required to meet compliance with existing regulatory requirements. The amount of regulated substance "available" to be avoided through measures required by the final rule was determined using EPA's Vintaging Model and refrigerant-containing equipment characterization assumptions detailed in section 3.2 above. Additional details on these assumptions as well as cost assumptions can be found in Appendices A, B, and C of this RIA Addendum.

The use of a MAC approach allows for consistency and comparability with EPA's prior results and for assessment of the costs of the final rule within the context of EPA's previously finalized regulations under the AIM Act. Similar to the approach taken for the 2023 Technology Transitions Rule, all abatement activities required to achieve compliance with the rule are assumed to occur in the compliance pathway. This differs from the approach originally used for the Allocation Framework Rule, which is agnostic in terms of the specific abatement measures that industry may take up in order to meet compliance with the statutory phasedown caps. Whereas for the Allocation Framework Rule a least-cost pathway was modeled which included only the level of abatement necessary to meet the statutory caps in each step-down year, the approach taken for the final ER&R rule as well as the 2023 Technology Transitions Rule assumes a specific compliance pathway informed by the sector-, subsector, and/or end-use-specific requirements of the rule.

Abatement Measures Modeled

This analysis uses the full set of required industry transitions previously modeled in the 2023 Technology Transitions Rule RIA addendum as the starting point from which potential incremental costs may be evaluated (i.e., the "base case" from the 2023 Technology Transitions RIA addendum). As discussed in the Allocation Framework Rule RIA, abatement measures can stem from a variety of compliance strategies, including reducing the amount of HFCs used in a piece of equipment (e.g., lowering charge sizes) and transitioning from using HFCs to alternatives such as hydrocarbons, ammonia, and hydrofluoroolefins (HFOs), which are not covered by the provisions of this rule as long as their GWP is 53 or lower, or HFC/HFO blends, which are covered by this rule as they contain an HFC. To model specific requirements from the final ER&R rule, EPA evaluated abatement measures falling into the following two general categories:

- Direct reduction in HFC losses from equipment (e.g., through leak repair)
- Use of reclaimed/recycled HFCs (e.g., to meet equipment servicing and/or repair or initial installation demand)

Table 3-9 below provides a summary of abatement measures modeled to evaluate the impact of specific ER&R rule requirements. For each abatement option modeled, total net costs associated with the strategy (e.g., leak detection costs minus any anticipated savings from reduce refrigerant consumption) are divided by the total amount of avoided HFC consumption to derive a cost estimate on a dollars-per-ton CO2e basis. Based on this approach, the average dollar-per-ton "break-even" cost tends to be lower for larger appliances or subsectors with large charge sizes, as opposed to smaller pieces of equipment where the amount of tons avoided per dollar is lower and hence the break-even cost is higher. For example, leak repair of large IPR systems has an estimated consumption abatement cost of approximately $1 per ton, whereas leak repair of medium IPR systems has an estimated consumption abatement cost of approximately $38 per ton.[20] Appendix E contains additional details on all abatement options developed and modeled for the final rule as well as their assumed break-even abatement costs in dollars per ton. Specific factors included in overall dollar-per-ton costs include equipment capital costs (e.g., ALD systems), labor costs (e.g., for conducting inspections and repairs), and savings associated with the avoided purchase of HFCs for servicing. For details on the bottom-up approach taken to estimate these factors for all affected equipment, including underlying data and assumptions used, see Appendix A.

[20] Unless stated elsewise, monetary figures are in 2022 U.S. dollars.

Table 3-9 - Summary of abatement measures modeled and key factors evaluated to derive MAC estimates

Type of abatement strategy modeled	***Corresponding ER&R Rule Requirements***	***Key Factors Evaluated to develop MAC abatement measure***
Direct reduction in HFC losses from equipment	• Leak detection and repair for appliances containing 15 lbs or more of refrigerant • Use of ALD systems for CR and IPR appliances containing 1,500 pounds or more of refrigerant • Minimize releases of HFCs during the servicing, repair, disposal, or installation of fire suppression equipment containing HFCs or during the use of such equipment for technician training	**Abatement:** avoided virgin HFC consumption required to meet servicing demand **Costs:** labor and equipment for conducting leak detection/ inspections and repairs; capital and O&M costs for ALD systems **Savings:** HFC savings associated with detecting and repairing refrigerant leaks earlier and avoiding refrigerant and fire suppression agent emissions
Use of reclaimed/ recycled HFCs	• Use of reclaimed refrigerant for servicing and/or repair of refrigerant-containing equipment for specific RACHP subsectors • Use of recycled HFCs for initial installation of fire suppression equipment • Use of recycled HFCs for servicing and/or repair of existing fire suppression equipment	**Abatement:** avoided virgin HFC consumption required to meet demand for initial installation or servicing **Costs:** cost of reclaimed/recycled HFCs vis a vis virgin manufactured HFCs **Savings:** avoided purchase of virgin HFCs

Table 3-10 below shows which provisions of the final rule were modeled to apply to which end-uses within the RACHP sector, and which charge size groups of those end-uses.

Table 3-10 – *Applicability of Requirements by Appliance Sector and Equipment Type*

Sector	***Equipment Type***	***Distributed Charge Size Group***	***Average Charge Size (lbs)***	***Provision (Start Date)***		
				Leak Inspection &Repair (2026)	***Use of ALD (2026/2027)[a]***	***Reclaimed Refrigerant Servicing (2029)***
Comfort Cooling	School & Tour Bus AC	Low	11			
		Average				
		High		√		
	Transit Bus AC	Low	16			
		Average		√		
		High		√		
	Passenger Train AC	Low	41	√		
		Average		√		
		High		√		

Sector	Equipment Type	Distributed Charge Size Group	Average Charge Size (lbs)	Provision (Start Date)		
				Leak Inspection &Repair (2026)	Use of ALD (2026/2027)[a]	Reclaimed Refrigerant Servicing (2029)
	CFC-11 Centrifugal Chillers	Low		√		
		Average	1,504	√	√	
		High		√	√	
	CFC-12 Centrifugal Chillers	Low		√		
		Average	1,566	√	√	
		High		√	√	
	R-500 Chillers	Low		√		
		Average	2,012	√	√	
		High		√	√	
	CFC-114 Chillers	Low		√		
		Average	1,389	√		
		High		√	√	
	Screw Chillers	Low		√		
		Average	661	√		
		High		√		
	Scroll Chillers	Low		√		
		Average	529	√		
		High		√		
	Reciprocating Chillers	Low		√		
		Average	529	√		
		High		√		
Commercial Refrigeration	Modern Rail Transport	Low				√
		Average	17	√		√
		High		√		√
	Vintage Rail Transport	Low		√		√
		Average	33	√		√
		High		√		√
	Condensing Unit	Low		√		
		Average	47	√		
		High		√		
	Road Transport[b]	Low				√
		Average	10			√
		High				√
	Intermodal Containers[b]	Low				√
		Average	10			√
		High				√
	Reefer Ships	Low		√		√
		Average	1,653	√	√	√
		High		√	√	√
	Merchant Fishing Transport	Low		√		√
		Average	388	√		√
		High		√		√
		Low	2,038	√		√
		Average		√	√	√

Sector	Equipment Type	Distributed Charge Size Group	Average Charge Size (lbs)	Provision (Start Date)		
				Leak Inspection &Repair (2026)	Use of ALD (2026/2027)[a]	Reclaimed Refrigerant Servicing (2029)
	CFC-12 Large Retail Food (supermarkets)	High		√	√	√
	R-502 Large Retail Food (supermarkets)	Low	2,038	√		√
		Average		√	√	√
		High		√	√	√
	CFC-12 Cold Storage	Low	25,431	√	√	
		Average		√	√	
		High		√	√	
	HCFC-22 Cold Storage	Low	24,220	√	√	
		Average		√	√	
		High		√	√	
	R-502 Cold Storage	Low	24,613	√	√	
		Average		√	√	
		High		√	√	
	Ice Makers[b]	Low	6			√
		Average				√
		High				√
Industrial Process Refrigeration	CFC-11 IPR	Low	1,945	√		
		Average		√	√	
		High		√	√	
	CFC-12 IPR	Low	2,078	√		
		Average		√	√	
		High		√	√	
	HCFC-22 IPR	Low	15,877	√	√	
		Average		√	√	
		High		√	√	

[a] Where required, refrigerant-containing appliances that were installed on or after January 1, 2017, and before January 1, 2026, must include an ALD system as of January 1, 2027. Refrigerant-containing appliances installed on or after January 1, 2026 must include an ALD system upon installation or within 30 days of installation of the refrigerant-containing appliance.
[b] Road Transport and Intermodal Containers average charge sizes are less than 10 pounds but shown as rounded values. Therefore, these appliance types (even under the "High" distributed charge size group) along with Ice Makers are not affected by the leak repair or ALD provisions but are affected by the reclaim provisions.

Model limitations and assumptions regarding the impact of reclaim requirements

The EPA Vintaging Model estimates HFC consumption and the resulting emissions without explicitly defining the mix of virgin vs. reclaimed or recycled gases that is used by end use category. Certain assumptions were necessary to determine the reduction in consumption and emissions attributable to reclamation activity as: (1) the ER&R rule provisions pertaining to reclaimed HFCs allow for reclaimed HFCs to be mixed with up to 15 percent virgin HFCs; and (2) some reclamation activity would be expected to occur in the absence of this rule. To account for these factors, the modeled change in consumption for options requiring reclaimed HFCs is scaled to remove the proportion not attributable to the rule. Thus, for a particular measure requiring reclaim, the change in consumption is determined as,

$$\Delta C_r = \Delta C_0(1-(p_b+p_v))$$

where $\boldsymbol{\Delta C_0}$ is the initially calculated change in consumption from the Vintaging Model (e.g., total demand for a given end use to be met using reclaimed HFCs), $\boldsymbol{p_b}$ is the proportion attributable to reclamation already assumed in the reference case, and $\boldsymbol{p_v}$ is the proportion coming from virgin HFCs (assumed to be 15%, i.e., the maximum share allowable).

Specific approaches for determining consumption and emission reductions resulting from ER&R rule abatement measures are summarized as follows:

- For measures in which the required use of recovered/reclaimed HFCs was modeled:
  - Consistent with the above formula, EPA first factored out share of demand already met by recovery and reclamation activity assumed in the reference case[21], and the 15% maximum share of virgin HFCs that may be included in "reclaimed" refrigerant per regulatory definitions was also factored out.
  - EPA conservatively assumed that the measure would not result in an additional reduction in emissions beyond the emissions reductions from recovery of HFCs and avoided venting at disposal and servicing already included in the reference case.
- For measures in which a direct reduction in HFC losses from equipment was modeled (e.g., due to leak repair or ALD requirements), and the affected equipment category was not covered by a use of reclaim for servicing requirement, it was assumed the servicing demand would have been met using virgin HFCs. A reduction in consumption of virgin HFCs equivalent to total avoided emissions was assumed.
- For measures in which a direct reduction in HFC losses from equipment was modeled (e.g., due to leak repair or ALD requirements), and the affected equipment category was also covered by a use of reclaim for servicing requirement, it was assumed the servicing demand would have been met through reclaimed HFCs. The full emission reduction associated with the leak repair activity was assumed. EPA then used the above methodology to convert from emissions reductions to consumption reductions attributable to the rule.

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[21] A reference case share of demand met by recovery and reclamation of 26.5% was used, derived from the Vintaging Model BAU. For more details, see Appendix E.

For more details on these and other specific assumptions applied to the abatement measures modeled for this rule, see Appendix E.

Updated MAC Compliance Path

The leak repair, automatic leak detection, fire suppression, and use of reclaim provisions modeled as abatement measures each have a net cost or savings estimated per ton of CO2 equivalent consumption or emissions avoided. To evaluate the incremental cost of these provisions relative to EPA's previous analysis, these options were integrated with the set of MAC options previously assumed to achieve compliance with the Allocation and 2023 Technology Transitions Rules. The result is an updated compliance path which combines ER&R Rule provisions' measures with those previously modeled.

For reference, Figure 3-3 below shows the consumption MAC curves associated with the Allocation Rules and 2023 Technology Transitions Rule compliance path. These curves illustrate all compliance measures modeled to be achieved as result of implementation of these rules, with each point representing the dollar-per-ton cost associated with abatement at a given threshold when moving (left-to-right) from lowest-to-highest cost measures. The compliance path for these previous rules is the reference case for this analysis, and is shown for 2026 (the first compliance year for the ER&R rule) and 2036 (the final step-down year under the Allocation Rules). These curves illustrate all measures assumed in the compliance path in each year from lowest-cost to highest-cost, with total consumption abatement reaching approximately 242.3 MMT CO2e in 2026 and 323.1 MMT CO2e in 2036.

Figure 3-3 – Marginal Abatement Cost Curves in 2026 and 2036 – Allocation and 2023 Technology Transitions Rule Reference Case

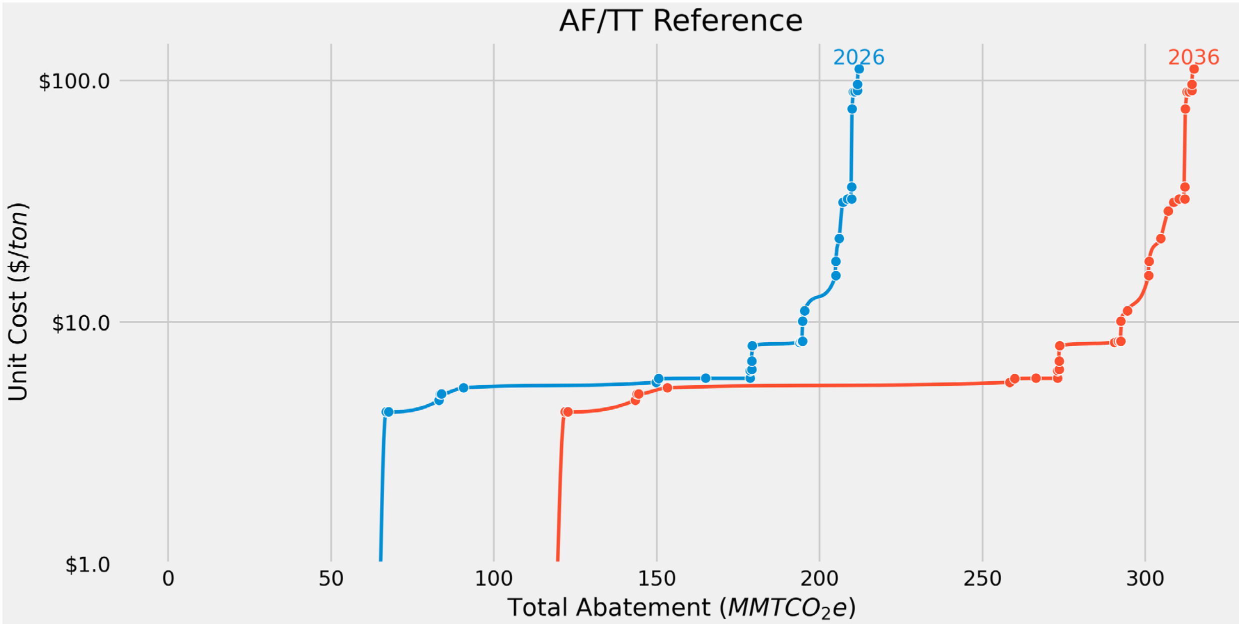
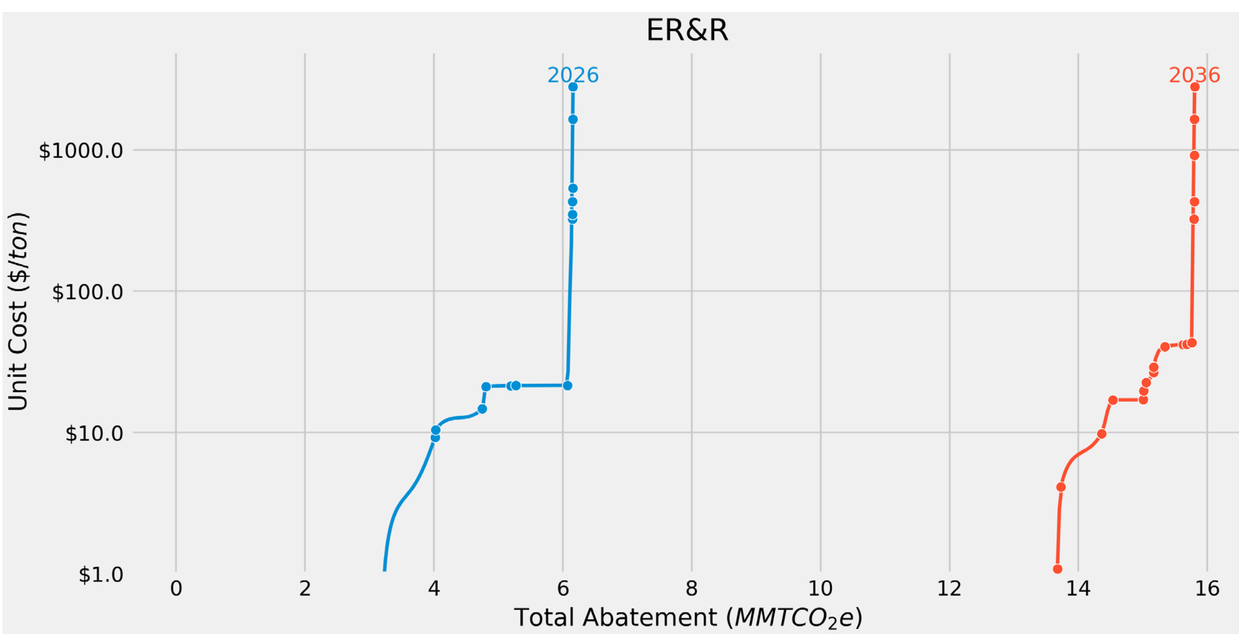


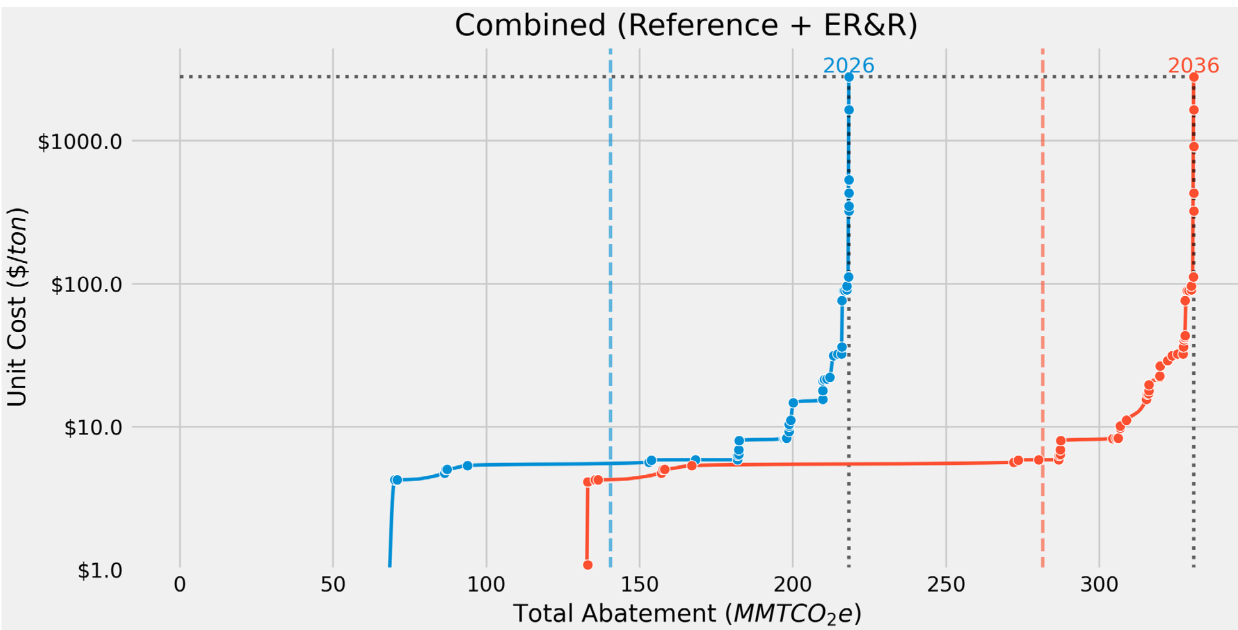
Figure 3-4 below then shows the additional abatement measures modeled for the final ER&R Rule described in the preceding sections. As shown, consumption abatement from these measures reaches an additional approximately 3.7 MMT CO2e in 2026 and 7.3 MMT CO2e in 2036.

Figure 3-4 – Marginal Abatement Cost Curves in 2026 and 2036 – Additional ER&R Rule Measures



Finally, Figure 3-5 below shows the integrated MAC curves reflecting both the reference case compliance measures assumed for the Allocation and 2023 Technology Transitions Rules as well as the updated measures evaluated for the final ER&R Rule. These curves illustrate total abatement assumed and assumed costs-per-abatement measure for the full suite of existing AIM Act regulations including the final ER&R Rule. A dashed vertical line showing the total amount of abatement required by the Allocation Rule (i.e., the abatement necessary to meet the HFC phasedown steps) in 2026 (blue) and 2036 (red) is provided for reference.[22]

Figure 3-5 – Revised Integrated Cost Curves in 2026 and 2036 –Allocation and 2023 Technology Transitions Rules with additional ER&R Rule measures



[22] However, the schedule for the production and consumption phasedown is not made more stringent than the schedule under subsection (e)(2)(C) of the AIM Act (i.e., the production and consumption caps contained in the Allocation Rules are unchanged).

3.4 Other Costs from Rule Requirements

Certain requirements contained in the final rule were not modeled using a MACC approach described above, either because they do not directly impact HFC consumption and emissions or because they relate to HFC consumption and emissions sources that are exogenous to the Vintaging Model. For these measures, separate approaches were used to evaluate compliance costs and avoided consumption and/or emissions of HFCs, as detailed below. These measures include:

- Requirements pertaining to the management of disposable cylinders of refrigerants and fire suppressants
- Alternative Resource Conservation and Recovery Act (RCRA) standards for ignitable spent refrigerants being recycled for reuse
- Recordkeeping and reporting requirements

Disposable cylinder management requirements

The provisions of this Rule include requirements to remove the heel from used disposable cylinders before the cylinders are discarded; the requirement covers disposable cylinders used for servicing, repair, disposal, or installation of refrigerant-containing appliances. For analytical purposes, the Agency focused on anticipated additional reductions in HFC consumption and emissions as well as industry costs and the potential savings from avoided refrigerant loss.

To assess the impact of these provisions, EPA relied in part on the report, *Refrigerant Cylinders: Updated Analysis of Use, Disposal, and Distribution of Refrigerants* (EPA 2024a), analyzing the costs and benefits of the requirement that disposable cylinders that have been used for the servicing, repair, or installation of refrigerant-containing equipment be transported to an EPA-certified reclaimer or another final processor within the supply and disposal chain (e.g., a distributor, repackager, wholesaler, landfill operator, or scrap metal recycler), and that these entities remove all HFCs (i.e., heel) from disposable cylinders prior to discarding the cylinder. If the heel is removed by a final processor or otherwise in the supply and disposal chain, the removed heels may be consolidated, but must be sent to an EPA-certified reclaimer or a fire suppressant recycler.

The report assesses the typical distribution of refrigerants in cylinders, including refrigerant changes expected under the Base Case; i.e., the scenario incorporating the 2023 Technology Transitions Rule. Based on the wide range of disposal practices currently employed and expected to continue in absence of this final rule, three scenarios were developed to estimate the emissions avoided: a low scenario (i.e., a lower heel left in the cylinder), a central scenario, and a high scenario.

The emissions avoided by removing such heels are dependent on the number of disposable cylinders in circulation and the average heel that would otherwise be emitted, and hence not available for reclaim, in absence of this rule. Based on the report cited above, we assume in the central scenario that there are approximately 4.5 million cylinders in circulation, of which 99 percent are disposable. Further, we estimate that the average heel is approximately 4 percent by weight of the nominal capacity (e.g., 0.96 pounds for a 24-pound cylinder).[23] Because of the other regulations in place, it is expected that the average GWP of the refrigerant in such cylinders will decrease. Other emissions associated with cylinders—for example, during transport and storage—are not expected to change based on this rule.

To account for the costs associated with the change in procedure handling of cylinders (i.e., returning the cylinders for heels to be removed) we analyze possible ways a cylinder might travel before the heel is removed and the truly-empty cylinder is landfilled or recycled. This analysis assumes that some cylinders will be: (a) sent directly to the reclaimer; (b) returned to a wholesaler or distributor, who will ship disposable cylinders to a landfill or steel recycling facility, which would combine heels for shipment to a reclaimer; and (c) shipped directly from the end-user or technician to a landfill or steel recyling facility, which would combine heels for shipment to a reclaimer. For paths (b) and (c) above, we assume the landfill or steel recycling facility would reduce costs by combining 25 refrigerant heels (at 0.96 pounds as discussed above) of each HFC or blend containing an HFC (e.g., HFC/HFO blends) they receive into individual 24-pound cylinders before sending those to a reclaimer. After recovering heels, reclaimers are assumed to send disposable cylinders to a landfill or steel recycler.

Neat HFOs, which are not regulated substances under this rulemaking but are used in some RACHP equipment, are not accounted for in the analysis. For HFCs and blends containing an HFC, we divide cylinders equally amongst the transportation paths described above. Thus, we assume one-third follow path (a), one-third follow path (b), and one-third follow path (c). Table 3-11 displays the estimated mileage for each leg of the paths taken compared to the business-as-usual (BAU) route.

Table 3-11 – *Estimated Distances for Disposable Cylinder Transportation Compared with BAU (Miles)*[a]

Transportation Leg	***BAU***	***(a) End-user to Reclaimer to Landfill***	***(b) End-user to Distributor to Reclaimer***	***(c) End-user to Landfill***
Producer/Filler to Wholesale Distributor	1,000	1,000	1,000	1,000
Wholesale Distributor to End User/Technician	25	25	25	25
End User/Technician to Steel Recycler/Landfill	75	NA	NA	75

[23] R-404A is typically sold in a 24-pound cylinder. Cylinders for other HFC refrigerants are typically larger, from 25 to 50 pounds. We use 24 pounds as a conservative estimate here.

Transportation Leg	*BAU*	*(a) End-user to Reclaimer to Landfill*	*(b) End-user to Distributor to Reclaimer*	*(c) End-user to Landfill*
End User/Technician to Reclaimer	NA	50	NA	NA
End User/Technician to Wholesale Distributor	NA	NA	25	NA
Distributor or Reclaimer to Steel Recycler/Landfill	NA	75	75	NA
Landfill sending Recovered Refrigerant to Reclaimer[b]	NA	NA	75	75
Total Miles per Cylinder	**1,100**	**1,150**	**1,128**	**1,103**

[a] CARB (2011)
[b] Each cylinder sent represents 25 cylinders received with heels.

The additional travel costs are influenced by how many cylinders fit on a truck, the fuel to drive the extra distances, and the incremental labor for such. By removing heels that would have otherwise been emitted and hence not available for reclaim, an additional supply is provided that would offset virgin production providing additional benefits based on the cost of refrigerant. These assumptions are shown in Table 3-12 below.

Table 3-12 - Additional Disposable Cylinder Cost Assumptions

Factor (units)	*Value*	*Source*	*Notes*
Cylinders per Truck	1,120	CARB (2011)	
Average Truck Speed (miles per hour)	50	CARB (2011)	
Truck Transport Labor Rate ($/hour)	$53.59	U.S. Bureau of Labor Statistics (2023b)	May 2022 mean, including 110% overhead
Average Fuel Consumption (miles per gallon)	6.1	Geotab (2017)	Average across all states
Fuel cost ($/gallon)	$4.034	EIA (2024)	Price of diesel as of March 25, 2024
Cost of HFC refrigerant ($/pound)	$4		Consistent with past AIM Act analyses

Accounting for the fuel and labor associated with the additional shipment of cylinders and the cost of refrigerants, we estimate costs and benefits, and hence the net benefits, as shown in Section 4.2 below and Appendix M.

Further details on the costs and benefits of the cylinder management requirements and a sensitivity analysis around some of the assumptions above are provided in Appendix M.

RCRA alternative standards

The final rule includes alternative RCRA (Resource Conservation and Recovery Act) standards for ignitable spent refrigerant. The purpose of these alternative standards is to help reduce emissions of ignitable spent refrigerants to the lowest achievable level by maximizing the recapture and safe reclamation/recycling of such refrigerants during the maintenance, service, repair, and disposal of refrigerant-containing appliances. The estimated compliance costs and savings resulting from these alternative standards are provided in this RIA Addendum for informational purposes. However, because they fall under a separate statutory authority from the AIM Act, they are not directly incorporated into the overall compliance costs and benefits estimates associated with this rulemaking and presented elsewhere in this document.

These alternative standards may incentivize additional reclamation of ignitable spent refrigerant over disposal, although EPA has not assumed they will result in additional recovery and reclamation consumption and emissions benefits beyond those already accounted for in response to other provisions contained in the final ER&R rule. The alternative standards also are expected to result in an overall reduction in compliance costs for management of ignitable spent refrigerant under RCRA. Avoided costs include reduced transportation costs (hazardous waste manifest and transporter not required under the alternative standards), avoided compliance costs of complying with hazardous waste generator regulations for appliance owners and technicians, and avoided hazardous waste incineration costs for recovered ignitable spent refrigerant. Offsetting these avoided costs would be the cost to reclaimers for meeting the new standards for emergency preparedness and response, and for documenting that the ignitable spent refrigerant is not speculatively accumulated.

These cost estimates are heavily dependent on the future market for ignitable spent refrigerant sent for reclamation, which is difficult to predict with currently available data. In addition, because the alternative RCRA standards are voluntary, and regulated entities can always choose to disposed of ignitable spent refrigerant under the full RCRA standards if that is the economically preferred option, EPA anticipates that the RCRA alternative standards would either be economically neutral or result in an overall cost savings.

Reporting and Recordkeeping Requirements

The final rule includes provisions that are expected to result in additional recordkeeping and reporting costs for owners and operators of refrigerant-containing appliances related to leak repair and inspection. Additional recordkeeping and reporting costs are also anticipated for the requirement to include a certification that reclaimed refrigerant contains no more than 15 percent virgin HFC. For owners and operators of fire suppression systems, and entities that employ technicians who install or maintain fire suppression systems, additional reporting and recordkeeping requirements apply. All recordkeeping and reporting costs are calculated by multiplying the estimated burden (hours) times the average annual respondent hourly cost (labor plus overhead).

In deriving these costs, EPA identified applicable standard occupational classifications for each respondent and used the corresponding 2022 mean hourly rate from the Bureau of Labor Statistics (BLS 2023a). The resulting costs outlined in Table 3-13 are the average hourly administrative cost of labor plus overhead for private firms (assumed to be 110 percent).

Table 3-12 - Labor Rates

Respondent	***Bureau of Labor Statistics Information***			***Total***
	Standard Occupational Classification	***Occupational Title***	***Mean Wage***	
Technicians	49-9021	Heating, Air-Conditioning, and Refrigeration Mechanics and Installers	$27.63	**$58.02**
Owners/ Operators	17-2111	Health and Safety Engineers	$49.79	**$104.56**

A brief summary of the specific approaches and assumptions applied for all relevant recordkeeping and reporting requirements is provided below.

Requests for extensions to the leak repair and retrofit timelines

Owners or operators of CC, CR, and IPR appliances normally containing 15 or more pounds of HFC refrigerant can apply to EPA for an extension to the leak repair and appliance retrofit timeframe. The total number of extension requests for CC, CR, and IPR HFC equipment was estimated by scaling the number of extension requests estimated for Ozone Depleting Substance (ODS)-containing equipment in the supporting ICR 1626.18[24] based on the proportion of total HFC equipment to ODS equipment modeled in EPA's Vintaging Model (EPA 2023f).

Installation records

Consistent with the ICR, this analysis assumes 1.5 minutes of burden time each time a refrigerant-containing appliance is installed. Vintaging Model assumptions described in section 3.2 were used to identify the pool of affected appliances (i.e., new appliances with refrigerant charge sizes at or above 15 pounds) (EPA 2023f).

Purchase and service records

Consistent with the ICR, this analysis assumes 1.5 minutes of burden time each time a refrigerant-containing appliance that contains an HFC or a substitute for an HFC with a GWP greater than 53 is

[24] ICR 1626.18 was developed to estimate burden associated with reporting and recordkeeping of leak repair and inspection requirements for appliances containing more than 50 pounds of ODS refrigerant.

serviced.[25] Vintaging Model assumptions described in section 3.2 were used to identify the pool of affected appliances (i.e., all appliances with refrigerant charge sizes at or above 15 pounds) and the expected number of times that the affected appliances would be serviced. The total number of servicing events is assumed to be equal to the number of times that service technicians provide invoices (i.e., one time per year for all refrigerant-containing appliances with charge sizes at or above 15 pounds) (EPA 2023f).

Results of verification tests

The final rule includes leak repair regulations that require initial and follow-up verification tests on repairs made after the leak rate threshold is exceeded for a refrigerant-containing appliance. EPA's Vintaging Model was used to identify the affected pool of appliances (as described in section 3.2). For every occurrence of a refrigerant-containing appliance exceeding the applicable leak rate threshold, 1.5 minutes of burden time was assumed to maintain reports on the results of verification tests (EPA 2023f).

Leak inspections

The final rule requires that covered CR and IPR appliances with a refrigerant charge size less than 500 pounds or CC and other appliances with a refrigerant charge size of at least 15 pounds conduct a leak inspection once per calendar year until the owner or operator can demonstrate through leak detection calculations that the refrigerant-containing appliance has not leaked in excess of the applicable leak rate for one year. CR and IPR appliances with a refrigerant charge size from 500 pounds up to 1,500 pounds would be required to conduct a leak inspection quarterly (i.e., once per three-month period). Appliances, or portions of appliances, continuously monitored with an ALD system that is certified annually, including appliances with a refrigerant charge size of 1,500 or more pounds, would not be required to conduct an annual leak inspection. This analysis assumes that the recordkeeping time associated with maintaining leak inspection records is one minute. EPA's Vintaging Model was used to identify the affected pool of appliances (as described in section 3.2) (EPA 2023f).

Plans to retrofit appliances

The final rule requires that owners or operators of IPR, CC, and CR appliances normally containing 15 or more pounds of a refrigerant must develop and maintain a plan to retire or retrofit the appliance in the following cases after the applicable leak rate is exceeded: an owner or operator chooses to retrofit or retire rather than repair a leak, an owner or operator fails to take action to repair or identify a leak, or a refrigerant-containing appliance continues to leak above the applicable leak threshold after a repair

[25] This assumption is premised on service technicians already needing to record information on services for invoicing, so the only incremental burden is in saving the data to a record file. For the significant percentage of service companies that record service information digitally in apps or other software, no additional time is needed to save logged data.

attempt was made. The total number of retrofit requests for CC, CR, and IPR appliances containing 15 or more pounds of a refrigerant was estimated as 1 percent of all affected appliances leaking above the threshold (see section 3.2). For each retrofit plan, 8 hours of burden time was assumed.

Reports on systems that leak 125 percent or more

EPA is requiring owners/operators of refrigerant-containing appliances subject to the leak repair and inspection provisions to prepare and submit reports describing efforts to identify and repair leaks for appliances that leak 125 percent or more of the full charge in a calendar year. Using the assumptions in the ICR for ODS equipment and scaling proportionately based on the ratio of affected ODS and HFC appliances, this analysis estimates that approximately 417 appliances have an annual leak rate greater than 125 percent. For each refrigerant-containing appliance meeting or exceeding this leak rate threshold, 1 hour of burden time was assumed to prepare and submit a report for each occurrence.

Requests to cease a retrofit

The final rule allows owners/operators of appliances containing 15 or more pounds of refrigerant to submit a request to cease a retrofit if certain requirements are met, including an agreement to repair all identified leaks within one year of the retrofit plan's date. To estimate the costs for this reporting requirement, it was assumed that 5 percent of those that develop a retrofit plan will submit a request to cease their retrofit. Each request is assumed to take 30 minutes to complete.

Annual calibration of ALD system

The final rule requires owners/operators of refrigerant-containing appliances using ALD systems to maintain records regarding the annual calibration or audit of the ALD system. Records must be maintained each time an ALD system detects a leak, whether that be based on the applicable ppm threshold for a direct ALD system or the indicated loss of refrigerant measured in the ALD system. EPA assumes indirect ALD systems will collect and store this directly and no burden is assumed. For owners/operators of direct ALD systems, 1 minute of burden time is assumed.

Labeling of reclaimed material with no more than 15% virgin material

It was assumed that reclaimers already label material and, therefore, will only need to modify labels to indicate the batch contains no more than 15% virgin material. The label modification was assumed to require 9 hours of both graphic design and administrative work.

Fire Suppression requirements

The final rule requires recordkeeping and reporting in the Fire Suppression sector. Those who first fill a fire suppression equipment with a regulated substance must report annually on the amount of such substances based on what is sold, recovered, recycled or virgin material and likewise on material sent for disposal. In addition, fire suppression technician employers must maintain records regarding the training used and documentation that the training was provided. Owners and operators of fire suppression equipment must also maintain records documenting that the regulated substances were recovered prior to sending the equipment for disposal. All records must be maintained for three years. EPA estimates that it will take 9.4 hours annually for the reporting, and an additional 40 hours annually for recordkeeping, per entity. We assume there will be 20 entities that will be required to perform the recordkeeping and reporting, including 15 reporters that already collect and share information under the voluntary HFC Emissions Estimating Program (HEEP).

3.5 Monetization of Emissions Benefits

The primary benefits of this final rule would derive from preventing the emissions of HFCs, thus reducing the damage from climate change that would have been induced by those emissions. The 18 HFCs and their isomers regulated under the AIM Act are GHGs that can trap much more heat per ton emitted than CO_2, a ratio shown in each chemical's GWP. The ratio of the amount of heat trapped by one ton of a chemical in the 100 years after it is emitted to the amount of heat trapped by one ton of CO_2 in 100 years after being emitted is the chemical's 100-year GWP, and the HFCs regulated under the phasedown have 100-year GWPs ranging from 53 to 14,800[26], with the vast majority of HFCs emitted having GWPs over 1,000. Prior to HFC regulation under the AIM Act, it was anticipated that HFC use and emissions would continue to rise, helping to drive global climate change. Thus, reducing the amount of HFCs that are used and emitted prevents climate damage and associated social costs that would have been induced by those HFC emissions. A more complete discussion of climate change damages and the social benefits of preventing them can be found in Sections 4.1 and 4.2 of the Allocation Framework Rule RIA.

While there may be other benefits to reducing emissions and increasing reclamation of HFCs, the benefits monetized in this analysis are limited to the climate benefits of reduced HFC emissions. More details on the social cost of HFCs (SC-HFC) methodology applied for this analysis and resulting monetized climate benefits can be found in Chapter 5.

3.6 Other Potential Benefits of this Rule

The estimated benefits of this rule that are quantified and presented in this analysis are the benefits of avoiding GHG emissions that would contribute to climate damages. There are, however, additional

[26] EPA has determined that the exchange values included in subsection (c) of the AIM Act are identical to the 100-year GWPs included in IPCC (2007). In this context, EPA uses the terms "global warming potential" and "exchange value" interchangeably. One MTEVe is therefore equivalent to one $MTCO_2e$.

potential benefits that would follow from the provisions, some of which that are not quantified in this analysis.

The provisions that require leak inspections, the repair of leaks, and/or the installation of ALD systems for certain refrigerant-containing appliances are best practices for the maintenance and upkeep of such appliances. Following such best practices accrues benefits for the owner/operator of the appliance by reducing the loss of refrigerant, resulting in savings that are estimated in this analysis. Many unquantified benefits from such best practices also exist. A regular practice of inspecting refrigerant-containing appliances and repairing leaks when detected (rather than topping-up the appliance) also prevents such appliances from breaking down as often and can prolong the effective service life of the appliances.[27] Fewer repairs of broken appliances and extending their service life directly benefits owner/operators, and in the case of refrigerant-containing appliances, reducing operation failures has the additional benefit of reducing the loss of refrigerated stock.[28] The costs of a refrigerant-containing appliance at a retail store failing and thousands of pounds of perishable stock being lost are considerable, and the aggregate costs of such food waste to the U.S. economy are also significant. In 2021, approximately 344,000 MT of food were lost due to refrigerant-containing equipment issues in the retail and food service sectors, with a value of $1.87 billion.[29]

The provisions of this rule designed to maximize reclaim would provide a number of additional benefits that are not quantified. As the HFC phasedown progresses, the supply of virgin HFCs will be reduced, but the demand for refrigerants, fire suppression agents, aerosol propellants, etc. may continue to grow. When complying with restrictions set by the 2023 Technology Transitions Rule, many uses of HFCs are expected to transition to using lower-GWP—and in some cases non-HFC—substitutes, but it is expected that demand for HFCs will continue, in part based on historic experience with the ODS phaseout. For example, although halons have not been produced or imported into the United States for decades, recycled halons are still used for the initial installation and servicing of certain fire suppression equipment. Reclaimed and recycled HFCs will be needed to meet the continuing demand and to meet certain requirements in the Rule.

By avoiding supply shortages of HFCs that are still needed for servicing certain appliances, maximizing reclaim avoids the economic disruption that might occur, including the stranding of equipment. A robust supply of reclaimed refrigerant would also protect the cold chain needed to deliver

[27] Crippa, 2021; Barnish, 1997
[28] Brush, 2011
[29] ReFED 2020

food and vaccines. Maximizing reclaim would also benefit sectors not directly covered by provisions of this rule, including certain specialized uses that cannot use reclaimed HFCs.

Chapter 4. Compliance Costs

Using the methodological approaches described chapter 3 of this RIA addendum, EPA has estimated the compliance costs associated with the provisions contained in the final ER&R Rule. Compliance costs also include all estimated savings (e.g., savings associated with avoided purchase of virgin refrigerant) and may therefore be net negative in certain cases.

The sections below summarize the estimated compliance costs for all relevant provisions contained in the final rule.

4.1 Leak repair and inspection, reclamation, and fire suppression requirements

As described in chapter 3, compliance costs for the leak repair and inspection, reclamation, and fire suppression requirements contained in the final rule were estimated using a marginal abatement cost (MAC) modeling approach. The additional HFC consumption- and emissions-reducing measures required by the final rule and their associated costs were estimated on a cost-per-ton of CO2e basis and integrated with the broader set of abatement measures previously assumed in the compliance path for the Allocation and 2023 Technology Transitions Rules. Results of the base case scenario from the 2023 Technology Transitions Rule RIA Addendum were used as the status quo from which the incremental costs stemming from the additional ER&R measures were evaluated.

Table 4-1 below shows the estimated incremental costs for a subset of model years included in the analysis by provision type.

Table 4-1- Incremental Annual Compliance Costs of MAC Abatement Measures (Millions 2022$)

Year	Leak Repair/ALD	Use of Reclaim for Servicing	Fire Suppression Requirements
2026	$79.5	$-	$0.2
2030	$88.3	$3.9	$0.8
2035	$75.0	$3.1	$0.9
2040	$57.5	$2.3	$0.9
2045	$43.4	$1.8	$1.0
2050	$43.3	$1.9	$1.0

The cost curves below illustrate an updated, integrated compliance path that includes the abatement measures assumed in for the Allocation and 2023 Technology Transitions Rules compliance pathway along with the additional abatement measures required by the ER&R rule. The curves present rolling total compliance costs and U.S. HFC consumption in a given year as abatement measures are applied from lowest- to highest-cost measures (left to right). The curves help to show the relationship between total abatement and costs. Notably, and as illustrated in Table 4-1 above, for certain ER&R measures such as leak repair annual abatement and costs decreases over time as HFCs in remaining stocks of equipment reduces. By contrast, abatement and costs (or savings) for the previously modeled 2023 Technology Transitions Rule build over time as the market penetration of HFC alternatives builds over time. The curves represent all options assumed to be undertaken to meet compliance, so the rightmost data point shows the resulting abatement and total cost in a given year (i.e., the rightmost points represent final abatement and net costs in each year after all required measures are applied).

Figure 4-1 – Integrated Annual Abatement Pathways under AIM Rules

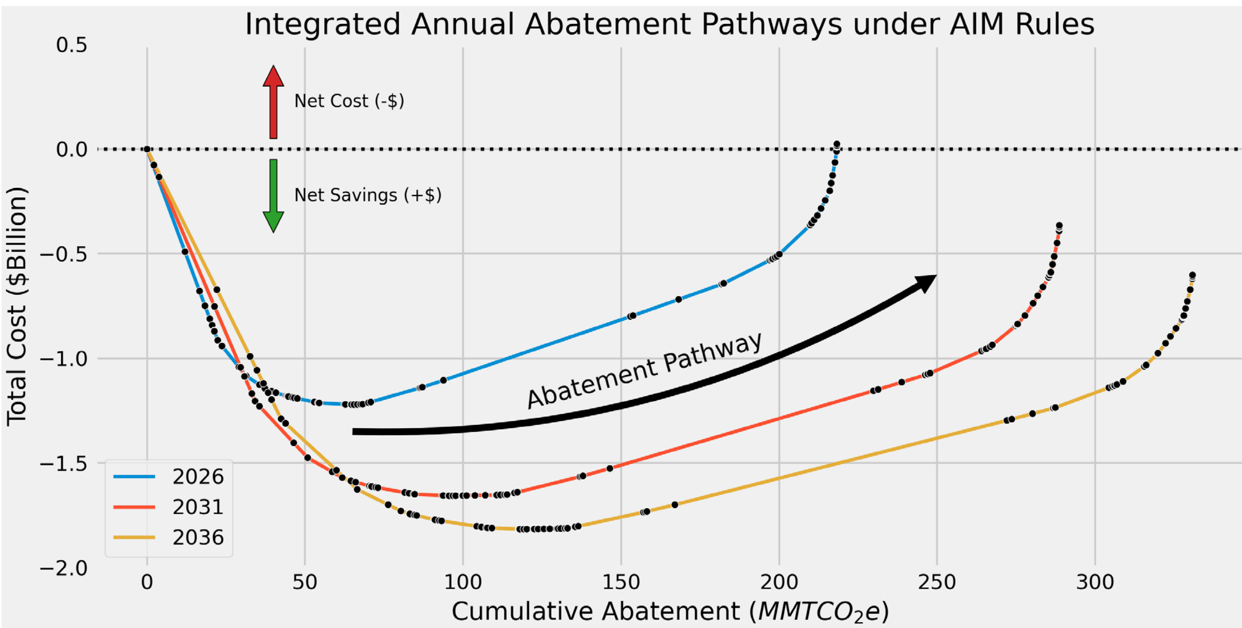


Figure Description: The curves above start with total costs incurred with the cheapest (or most cost-effective) abatement measures applied, with more expensive options added as the curve moves left to right. Points to the left of the low point on each curve represent measures with assumed net negative costs (or cost savings), while points to the right of the low point on each curve represent measures with assumed net positive costs. The rightmost point on each curve for a given year in each figure represents the final total net cost with all required abatement options being applied.

4.2 Disposable cylinder management requirements

To assess the impact of these provisions, EPA relied in part on the report, *Refrigerant Cylinders: Updated Analysis of Use, Disposal, and Distribution of Refrigerants* (EPA 2024a). The report assesses the cost implications for the requirement for heel removal, accounting for the costs associated with the change in procedure handling of cylinders (e.g., transporting the cylinders for heel removal prior to discarding the cylinder) and the potential savings from avoided refrigerant loss from heel emissions.

Because neat HFOs, CO2, ammonia, and hydrocarbons are not regulated substances, these costs and benefits do not reflect possible handling of those refrigerants. For the cylinders containing HFCs (and blends containing HFCs), this analysis assumes that one third will be returned directly to a reclaimer, another third will be returned to a distributor, and the other third will be shipped directly to a landfill or scrap recycling center.

Table 4-2 below summarizes the estimated net costs of these requirements for a subset of model years from 2025-2050. Further detail including sensitivity analyses around some of the assumptions may be found in Appendix M.

Table 4-2 Estimated Compliance Costs for Cylinder Management Provisions (Millions 2022$)

Year	Transportation Costs	Refrigerant Savings	Net Costs
2028	$0.14	$12.9	-$12.8
2030	$0.14	$12.6	-$12.4
2035	$0.13	$11.7	-$11.6
2040	$0.12	$11.3	-$11.2
2045	$0.12	$11.1	-$10.9
2050	$0.12	$11.0	-$10.9

4.3 RCRA alternative standards

As described in Chapter 3, the amendments to RCRA standards for reclaimers are anticipated to be cost neutral or to provide some savings from reduced compliance burden on these entities. As documented in the ICR (ICR Number 2778.01), the average annual reduction in compliance burden is approximately $2,131,844. Taking this value as the net benefit of the amendments for each year from 2026 (the first year in which the avoided costs are estimated to accrue) through 2050 and discounting the savings to 2024, the present value of the savings benefits would be $22.7 million (7 percent discount rate), $35 million (3 percent), or $40 million (2 percent). As discussed in Chapter 3, due to uncertainty and the voluntary nature of the alternative standards, the net benefits may be lower and are shown in this document as a range from $0 to the discounted values above. In addition, these standards fall under a separate statutory authority from the AIM Act and are therefore not incorporated into the overall compliance costs and benefits estimates associated with this rulemaking presented elsewhere in this document.

4.4 Recordkeeping and reporting requirements

The final ER&R rule contains several provisions that EPA has estimated will result in additional recordkeeping and reporting cost burden for affected industries. EPA has prepared an information collection request (ICR), ICR Number 2778.01, and a Supporting Statement which can be found in the docket.[30] The information collection requirements for recordkeeping, reporting, and labeling are not enforceable until OMB approves them. Among other things, EPA calculated the estimated time and financial burden over a three-year period (ICRs generally cover three-year time periods) for respondents to implement labeling practices and to electronically report data to the Agency on an annual basis. A summary of the respondent burden estimates follows. A summary of underlying assumptions and methods used can be found in section 3.4 of this document, and the full methodology for these calculations can be found in the docket.

For the three years covered in the ICR, the total respondent burden associated with information collection will average 4.8 million hours per year and the respondent cost will average $19.2 million per year. The breakdown of the burden per year is provided in Table 4-3 in 2022 dollars. The ICR will be subject to renewal after the three-year time period is over.

Table 4-3 Total Respondent Burden Costs Over the Three-year ICR Period (2022$s)

Year	***Total Responses***	***Total Hours***	***Total Labor Costs (2022$)***	***Total O&M Costs (2022$)***	***Total Costs (2022$)***
Year 1 (2026)	4,445,381	141,372	$12,155,355.28	$0.00	$12,155,355
Year 2 (2027)	4,810,033	223,029	$17,580,430.39	$0.00	$17,580,430
Year 3 (2028)	5,115,220	396,447	$27,869,424.28	$0.00	$27,869,424
3yr ICR Annual Average	4,790,211	253,616	$19,201,736.65	$0.00	$19,201,737

[30] Docket ID: EPA-HQ-OAR-2022-0606

Chapter 5. Climate Benefits

5.1 Consumption and Emission Reductions

EPA's Vintaging Model is used to estimate both consumption and emissions for each regulated substance for each generation or "vintage" of equipment in both a reference case scenario and policy compliance scenario. Reductions in consumption (in units of MMTEVe) are calculated for a given year by summing the total tons of virgin manufacture of HFCs avoided resulting from compliance with the rule across all end-uses. Emission reductions are similarly calculated by summing total HFC emissions avoided across end-uses in the compliance scenario. For many of the requirements contained in the final ER&R rule, emissions reductions are assumed to occur in the same year as corresponding reductions in consumption and vice versa. For example, leak repair and inspection measures result in avoided emissions from equipment leaks and an equivalent amount of avoided demand (i.e., consumption) that would otherwise be required to "top off" the leaking equipment. In this case, both the emissions reduction and equivalent consumption reduction are modeled as occurring in the same year. As another example, measures that require increased recovery of HFCs from equipment at disposal also yield a reduction in emissions (since it is assumed the gas would otherwise be released), however the timing of when this recovered material will be then be placed back onto the market as reclaimed refrigerant is uncertain and may well occur well after the material was recovered.

The reference case for this analysis includes baseline levels of recovery of HFCs and resulting avoided emissions, derived from the Vintaging Model BAU. While the requirements pertaining to use of reclaimed HFCs contained in the final rule may yield further recovery of HFCs and resulting avoided emissions, EPA has conservatively assumed that these measures do not necessarily yield incremental HFC emissions reductions beyond these baseline levels.[31] EPA has further assumed that not all reclaimed HFCs utilized for the servicing and/or repair of certain refrigerant-containing equipment would be in direct response to this rule, and that some reclamation would occur in the absence of policy. In this way,

[31] This assumption is made for technical analytic purposes and to avoid over-estimation of incremental benefits relative to the established model BAU relied upon for previous analyses including the Allocation Rules and 2023 Technology Transitions Rule RIA and RIA Addenda, and should not be interpreted as a reflection of the merits of any particular provision contained in the final rule.

EPA has conservatively estimated the amount of HFC recovery, re-use, and reclamation activity attributable to the rule's provisions versus the amount that would otherwise occur in the absence of the requirements. More details on these assumptions can be found in Chapter 3 as well as the appendices accompanying this document.

Due to these factors and assumptions, in the results presented below consumption and emission reductions resulting from the measures included in this analysis may not occur on a one-to-one basis in a given year and may also be less than the full amount of refrigerant demand affected by a particular provision. For more details on these assumptions, please see section 3.3 and Appendix E of this RIA Addendum.

Table 5-1 below shows the consumption reductions by year corresponding to the final ER&R Rule compliance scenario (base case) evaluated in this analysis. As discussed in Chapter 3 of this document, incremental benefits reflect reductions that are additional to the compliance scenario previously assessed by EPA in the 2023 Technology Transitions Rule RIA Addendum.

Table 5-1: Annual Incremental Consumption Reductions (MMTCO$_2$e) for ER&R Rule – Base Case Scenario

Year	Leak Repair and ALD	Fire Suppression	Use of Reclaim (Servicing)	Cylinder Management
2026	5.4	0.77	0.0	0.0
2030	4.7	4.1	12	2.1
2035	3.9	4.3	8.4	1.5
2040	2.6	4.5	5.7	1.1
2045	1.3	4.7	4.4	0.94
2050	0.68	4.9	4.5	0.90
Total (2026-2050)	**78**	**98**	**151**	**31**

Table 5-2 below shows the emissions reductions by year corresponding to the final ER&R Rule compliance scenario (base case) evaluated in this analysis. As discussed in Chapter 3 of this document, incremental benefits reflect reductions that are additional to the compliance scenario previously assessed by EPA in the 2023 Technology Transitions Rule RIA addendum.

Table 5-2: Annual Incremental Emissions Reductions (MMTCO$_2$e) for ER&R Rule – Base Case Scenario

Year	Leak Repair and ALD	Fire Suppression	Use of Reclaim (Servicing)	Cylinder Management
2026	5.4	0.01	-*	0.0
2030	5.6	0.01	-	2.1
2035	4.6	0.01	-	1.5
2040	3.0	0.01	-	1.1
2045	1.5	0.01	-	0.94
2050	0.92	0.01	-	0.90
Total (2026-2050)	**88**	**0.21**	**-**	**31**

*Reclaim requirements may lead to additional emissions reductions by inducing increased recovery of refrigerant at servicing and disposal that may otherwise be released or vented. In our base case scenario, EPA does not estimate an increase in these avoided emissions beyond reference case assumptions.

The mix and distribution of HFCs in refrigerant-containing appliances is anticipated to change significantly in the coming decades, resulting in different leak repair and inspection benefits for later years. As shown in Table 5-2 above, the annual GWP-weighted GHG emissions avoided from HFC refrigerants resulting from leak repair and ALD provisions in 2050 is less than half that of 2026. This is not due to decreased efficacy of leak repair or ALD systems or a decrease in use of refrigerant, but rather is a result of the reduction over time in the average GWP of the refrigerant contained in equipment that would otherwise leak.

5.2 Social Cost of HFCs

The primary benefits of this final rule are expected to derive from preventing the emissions of HFCs, thus reducing the damage from climate change that would have been induced by those emissions. The 18 HFCs and their isomers regulated under the AIM Act are GHGs that can trap much more heat per ton emitted than CO_2, a ratio shown in each chemical's GWP. The ratio of the amount of heat trapped by one ton of a chemical in the 100 years after it is emitted to the amount of heat trapped by one ton of CO2 in 100 years after being emitted is the chemical's 100-year GWP, and the HFCs regulated under the phasedown have 100-year GWPs ranging from 53 to 14,800, with the vast majority of HFCs emitted having GWPs over 1,000. Prior to HFC regulation under the AIM Act, it was anticipated that HFC use and emissions would continue to rise, helping to drive global climate change. Thus, reducing the amount of HFCs that are used and emitted prevents climate damage and associated social costs that would have been induced by those HFC emissions. A more complete discussion of climate change damages and the social benefits of preventing them can be found in Sections 4.1 and 4.2 of the Allocation Framework Rule RIA.[32] While there may be other benefits to phasing down HFCs, the benefits monetized in this analysis are limited to the climate benefits of reduced HFC emissions.

While CO_2 is the most prevalent GHG emitted by humans, it is not the only GHG with climate impacts. The EPA Endangerment Finding (2009) defined a basket of six gases as the GHG air pollutant addressed in the finding, comprising CO_2, methane (CH_4), nitrous oxide (N_2O), HFCs, perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). The climate impact of the emission of a molecule of each of these gases is generally a function of their lifetime in the atmosphere and the radiative efficiency of that molecule. We estimate the climate benefits for this rulemaking using estimates of the social cost of each HFC (collectively referred to as SC-HFC) that is affected by the rule. The SC-HFC is the monetary value of the net harm to society associated with a marginal increase in HFC emissions in a given year, or the benefit of avoiding that increase. In principle, SC-HFC includes the value of all climate change impacts, including (but not limited to) changes in net agricultural productivity, human health effects, property damage from increased flood risk and natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services. The SC-HFC, therefore, reflects the societal value of reducing emissions of the HFC in question by one metric ton. The SC-HFC is the theoretically appropriate value to use in conducting benefit-cost analyses of policies that affect HFC emissions.

The monetization of climate benefits in this analysis uses the same HFC-specific SC-HFC estimates as used in the proposal RIA and in the estimation of the benefits in the Allocation Framework Rule RIA. That is, for the primary benefits analysis in this final RIA, EPA uses SC-HFC estimates that are consistent with the methodology underlying the interim SC-GHG estimates presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 (IWG, 2021) that the Interagency Working Group on the SC-GHG (IWG) recommended for use until updated estimates that address the National Academies' recommendations are available. The SC-HFC estimates (shown in Appendix I) are presented in 2022 dollars per metric ton of HFC emitted by year. As explained in Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under E.O. 13990, it is appropriate for agencies to revert to the same set of four values drawn from the social cost of greenhouse gases (SC-GHG) distributions based on three discount rates as were used in regulatory analyses between 2010 and 2016 and subject to public comment (2.5 percent, 3 percent, and 5 percent), plus a fourth value, selected as the 95th percentile of estimates based on a 3 percent discount rate. The fourth value was included to provide information on potentially higher-than-expected economic impacts from climate change, conditional on the 3 percent estimate of the discount rate. In that document it was

[32] Available at: https://www.regulations.gov/document/EPA-HQ-OAR-2021-0044-0227

also found that the use of the social rate of return on capital (7 percent under current OMB Circular A-4 guidance) to discount the future benefits of reducing GHG emissions inappropriately underestimates the impacts of climate change for the purposes of estimating the SC-GHG. For purposes of capturing uncertainty around the SC-HFC estimates in analyses, we emphasize the importance of considering all four values for each HFC affected by the rule. For each HFC, the SC-HFC estimate increases over time within the models—i.e., the societal harm from one metric ton emitted in 2030 is higher than the harm caused by one metric ton emitted in 2025—because future emissions produce larger incremental damages as physical and economic systems become more stressed in response to greater climatic change, and because gross domestic product (GDP) is growing over time and many damage categories are modeled as proportional to GDP. A more complete discussion of the development of these SC-HFC estimates can be found in section 4.1 of the Allocation Framework Rule RIA.

In addition to the climate benefits presented in Section 5.3 below, in Appendix J, EPA presents the monetized climate benefits of the final rule using a new set of SC-HFC estimates that reflect recent advances in the scientific literature on climate change and its economic impacts and incorporate recommendations made by the National Academies of Science, Engineering, and Medicine (National Academies, 2017). The methodology underlying these updated SC-HFC estimates is consistent with the SC-GHG estimates used in the EPA's 2023 RIA for the Final Oil and Gas New Source Performance Standards (NSPS)/Emissions Guidelines (EG) Rulemaking, "Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review". As EPA noted in the proposal RIA for this rulemaking, EPA solicited public comment on the methodology and use of these estimates in the RIA for the agency's December 2022 Oil and Gas NSPS/EG Supplemental Proposal (U.S. EPA, 2022)[33] and has conducted an external peer review of these estimates, as described further below.

The EPA solicited public comment on the sensitivity analysis and the accompanying draft technical report, External Review Draft of Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances, which explains the methodology underlying the new set of estimates, in the December 2022 Supplemental Oil and Gas Proposal. The response to comments document can be found in the docket for that action.

To ensure that the methodological updates adopted in the technical report are consistent with economic theory and reflect the latest science, the EPA also initiated an external peer review panel to conduct a high-quality review of the technical report, completed in May 2023 (EPA, 2022). The peer reviewers

[33] EPA., 2022. Standard of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review. A Proposed Rule by the EPA on 12/06/22.

commended the agency on its development of the draft update, calling it a much-needed improvement in estimating the SC-GHG and a significant step towards addressing the National Academies' recommendations with defensible modeling choices based on current science. The peer reviewers provided numerous recommendations for refining the presentation and for future modeling improvements, especially with respect to climate change impacts and associated damages that are not currently included in the analysis. Additional discussion of omitted impacts and other updates have been incorporated in the technical report to address peer reviewer recommendations. Complete information about the external peer review, including the peer reviewer selection process, the final report with individual recommendations from peer reviewers, and the EPA's response to each recommendation is available on EPA's website [34]. Appendix J presents the climate benefits of the final rule using the updated methodology set forth in EPA 2022a for the calculation of SC-HFC. For more information on the updated SC-HFC estimates please see the files associated with this rule in the docket.

5.3 Monetized Climate Benefits Results

To monetize the climate benefits resulting from the final ER&R rule provisions evaluated in this analysis, the HFC emission reductions in each year are multiplied by the corresponding SC-HFC for that HFC in that year.

Table 5-4 below shows the undiscounted monetized incremental climate benefits from all regulated HFCs under the base case. When the base case benefits are discounted to 2024 using a discount rate of 3 percent, the present value of the incremental benefits of the final rule provisions evaluated in this analysis are estimated to be $8.4 billion in 2022 dollars (under a 3% constant discount rate). This is equivalent to an annual incremental benefit of $0.5 billion per year over that timeframe.

Table 5-3: Undiscounted Monetized Climate Benefits 2026–2050 (2022$)[a,b,c,d]

Year	***Base Case Incremental Climate Benefits (millions 2022$)***			
	SC-HFC Discount Rate and Statistic			
	2.5% Average	***3% Average***	***5% Average***	***3% 95th Percentile***
2025	0.00	0.00	0.00	0.00
2026	575.60	428.23	176.99	1135.18
2027	668.11	498.13	207.18	1320.79
2028	917.61	688.06	291.69	1824.96
2029	909.20	683.48	291.93	1813.19
2030	897.61	676.34	290.87	1794.60

[34] https://www.epa.gov/environmental-economics/scghg

2031	886.63	669.98	290.78	1780.27
2032	873.14	661.59	289.63	1760.36
2033	860.04	653.31	288.29	1740.60
2034	840.34	640.02	284.75	1707.37
2035	802.13	612.54	274.81	1636.13
2036	764.80	585.64	265.03	1565.35
2037	725.28	556.88	254.17	1489.50
2038	684.86	527.25	242.68	1411.27
2039	643.73	496.91	230.65	1331.04
2040	602.65	466.46	218.33	1250.43
2041	566.30	439.69	207.96	1179.91
2042	513.14	399.83	191.34	1074.31
2043	465.29	363.91	176.32	979.23
2044	429.78	337.48	165.60	909.50
2045	400.19	315.48	156.73	851.57
2046	376.06	297.64	149.71	803.68
2047	355.85	282.75	143.94	763.74
2048	340.13	271.28	139.68	732.97
2049	329.87	264.01	137.35	713.45
2050	327.61	262.88	137.81	710.32
PV	11587.67	8355.70	2994.78	22302.29
EAV	628.93	479.85	212.49	1280.77

[a] Rows may not appear to add correctly due to rounding.
[b] Present values are calculated using end of year discounting.
[c] The equivalent annual values of benefits are calculated over a 25-year period.
[d] Climate benefits are based on changes in HFC emissions and are calculated using four different estimates of the SC-HFCs (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate).

Unlike many environmental problems where the causes and impacts are distributed more locally, GHG emissions are a global externality making climate change a true global challenge. GHG emissions contribute to damages around the world regardless of where they are emitted. Because of the distinctive global nature of climate change, in the RIA for this final rule the EPA centers attention on a global measure of climate benefits from the HFC emission reductions.

Consistent with all IWG recommended SC-GHG estimates to date, Table 5-4 present the monetized global climate impacts of the HFC emission changes expected from the final rule. This approach is the same as that taken in EPA regulatory analyses from 2009 through 2016 and since 2021, including in the RIA for the proposal rule. It is also consistent with guidance in (OMB, 2003) (OMB, 2023) that recommends reporting of important international effects[35]. EPA also notes that EPA's cost estimates in RIAs, including the cost estimates contained in this RIA, regularly do not differentiate between the share of compliance costs expected to accrue to U.S. firms versus foreign interests, such as to foreign investors in regulated entities[36]. A global perspective on climate effects is therefore consistent with the approach EPA takes on costs. There are many reasons, as summarized in this section – and as articulated by OMB and in IWG assessments (IWG, 2010) (IWG, 2013) (IWG, 2016a) (IWG, 2016b) (IWG, 2021), the 2015 Response to Comments (IWG, 2015) and in detail in U.S. EPA (EPA, 2023) and in Appendix A of the Response to Comments document for the December 2023 Final Oil and Gas NSPS/EG Rulemaking – why the EPA focuses on the global value of climate change impacts when analyzing policies that affect GHG emissions.

International cooperation and reciprocity are essential to successfully addressing climate change, as the global nature of greenhouse gases means that a ton of GHGs emitted in any other country harms those in the U.S. just as much as a ton emitted within the territorial U.S. Assessing the benefits of U.S. GHG mitigation activities requires consideration of how those actions may affect mitigation activities by other countries, as those international mitigation actions will provide a benefit to U.S. citizens and residents by mitigating climate impacts that affect U.S. citizens and residents. This is a classic public goods problem because each country's reductions benefit everyone else, and no country can be excluded from enjoying

[35] The 2003 version of OMB Circular A-4 states when a regulation is likely to have international effects, "these effects should be reported"; while OMB Circular A-4 recommends that international effects we reported separately, the guidance also explains that "[d]ifferent regulations may call for different emphases in the analysis, depending on the nature and complexity of the regulatory issues." (OMB, 2003).
The 2023 update to Circular A-4 states that "In certain contexts, it may be particularly appropriate to include effects experienced by noncitizens residing abroad in your primary analysis. Such contexts include, for example, when:
• assessing effects on noncitizens residing abroad provides a useful proxy for effects on U.S. citizens and residents that are difficult to otherwise estimate;
• assessing effects on noncitizens residing abroad provides a useful proxy for effects on U.S. national interests that are not otherwise fully captured by effects experienced by particular U.S. citizens and residents (e.g., national security interests, diplomatic interests, etc.);
• regulating an externality on the basis of its global effects supports a cooperative international approach to the regulation of the externality by potentially inducing other countries to follow suit or maintain existing efforts; or
• international or domestic legal obligations require or support a global calculation of regulatory effects" (OMB 2023). Due to the global nature of the climate change problem, the OMB recommendations of appropriate contexts for considering international effects are relevant to the HFC emission reductions expected from the final rule. For example, as discussed in this RIA, a global focus in evaluating the climate impacts of changes in HFC emissions supports a cooperative international approach to GHG mitigation by potentially inducing other countries to follow suit or maintain existing efforts, and the global SC-HFC estimates better capture effects on U.S. citizens and residents and U.S. national interests that are difficult to estimate and not otherwise fully captured.
[36] For example, in the RIA for the 2018 Proposed Reconsideration of the Oil and Natural Gas Sector Emission Standards for New, Reconstructed, and Modified Sources, the EPA acknowledged that some portion of regulatory costs will likely "accru[e] to entities outside U.S. borders" through foreign ownership, employment, or consumption. In general, a significant share of U.S. corporate debt and equities are foreign-owned, including in the oil and gas industry.

the benefits of other countries' reductions. The only way to achieve an efficient allocation of resources for emissions reduction on a global basis — and so benefit the U.S. and its citizens and residents — is for all countries to base their policies on global estimates of damages. A wide range of scientific and economic experts have emphasized the issue of international cooperation and reciprocity as support for assessing global damages of GHG emission in domestic policy analysis. Using a global estimate of damages in U.S. analyses of regulatory actions allows the U.S. to continue to actively encourage other nations, including emerging major economies, to also assess global climate damages of their policies and to take steps to reduce emissions. Several recent studies have empirically examined the evidence on international GHG mitigation reciprocity, through both policy diffusion and technology diffusion effects. See U.S. EPA (EPA, 2023)[37] for more discussion.

For all of these reasons, the EPA believes that a global metric is appropriate for assessing the climate impacts of GHG emissions in this final RIA. In addition, as emphasized in the (National Academies, 2017) recommendations, "[i]t is important to consider what constitutes a domestic impact in the case of a global pollutant that could have international implications that impact the United States." The global nature of GHG pollution and its impacts means that U.S. interests are affected by climate change impacts through a multitude of pathways and these need to be considered when evaluating the benefits of GHG mitigation to U.S. citizens and residents. The increasing interconnectedness of global economy and populations means that impacts occuring outside of U.S. borders can have significant impacts on U.S. interests. Examples of affected interests include direct effects on U.S. citizens and assets located abroad, international trade, and tourism, and spillover pathways such as economic and political destabilization and global migration that can lead to adverse impacts on U.S. national security, public health, and humanitarian concerns. Those impacts point to the global nature of the climate change problem and are better captured within global measures of the social cost of greenhouse gases.

In the case of these global pollutants, for the reasons articulated in this section, the assessment of global net damages of GHG emissions allows EPA to fully disclose and contextualize the net climate benefits of HFC emission reductions expected from this final rule. The EPA disagrees with public comments received on the December 2022 Oil and Gas NSPS/EG Supplemental Proposal that suggested that the EPA can or should use a metric focused on benefits resulting solely from changes in climate impacts occurring within U.S. borders. The global models used in the SC-GHG modeling do not lend themselves to be disaggregated in a way that could provide comprehensive information about the distribution of the rule's climate impacts to citizens and residents of particular countries, or population groups across the

[37] EPA., 2023. Standard of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review.

globe and within the U.S. As discussed in the Allocation Framework Rule RIA, these estimates are only a partial accounting and do not capture all of the pathways through which climate change affects public health and welfare. Thus, they only cover a subset of potential climate change impacts. Furthermore, the estimates do not capture spillover or indirect effects whereby climate impacts in one country or region can affect the welfare of residents in other countries or regions— such as how economic and health conditions across countries will impact U.S. business, investments, and travel abroad.[38]

Additional modeling efforts can and have shed further light on some omitted damage categories. For example, the Framework for Evaluating Damages and Impacts (FrEDI) is an open-source modeling framework developed by EPA to facilitate the characterization of net annual climate change impacts in numerous impact categories within the contiguous United States (CONUS) (i.e., excluding Hawaii, Alaska, and U.S. territories) and monetize the associated distribution of modeled damages (Hartin et al., 2023; U.S. EPA, 2021).[39] The additional impact categories included in FrEDI reflect the availability of U.S.-specific data and research on climate change effects. Results from FrEDI show that annual damages resulting from climate change impacts within CONUS and for impact categories not represented in the latest global models are expected to be substantial. For example, applying U.S.-specific partial SC-HFC estimates derived from FrEDI to the HFC emission reductions expected under the final rule would yield substantial climate benefits. The present value of the climate benefits of the final rule as measured by FrEDI from climate change impacts in CONUS are estimated to be $2.98 billion (under a 2 percent near-term Ramsey discount rate)[40]. However, the numerous explicitly omitted damage categories and other modeling limitations discussed above and throughout U.S. EPA (EPA, 2023)[41] make it likely that these estimates underestimate the climate benefits to U.S. citizens and residents of the HFC emission reductions

[38]The limitations discussed in this paragraph also apply to the models used in the updated SC-HFC estimates used in Appendix J. For example, two of the models used to inform the updated methodology, the Greenhouse Gas Impact Value Estimator (GIVE) and Data-driven Spatial Climate Impact Model (DSCIM) models, have spatial resolution that allows for some geographic disaggregation of future climate impacts across the world. This permits the calculation of a partial GIVE and DSCIM-based SC-GHG measuring the damages from four or five climate impact categories projected to physically occur within the U.S., respectively, subject to caveats. As discussed at length in U.S. EPA (2023), these damage modules are only a partial accounting and do not capture all of the pathways through which climate change affects public health and welfare. For example, this modeling omits most of the consequences of changes in precipitation, damages from extreme weather events (e.g., wildfires), the potential for nongradual damages from passing critical thresholds (e.g., tipping elements) in natural or socioeconomic systems, and non-climate mediated effects of GHG emissions other than CO2 fertilization.

[39] The FrEDI framework and Technical Documentation have been subject to a public review comment period and an independent external peer review, following guidance in the EPA Peer-Review Handbook for Influential Scientific Information (ISI). Information on the FrEDI peer-review is available at the EPA Science Inventory (EPA Science Inventory, 2021).

[40] Please see the docket for the full calculation. The inputs to the FrEDI modeling are consistent with the methodological advances reflected in the updated SC-HFCs using in Appendix J.

[41] EPA., 2023. Standard of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review.

from the final rule.[42] The limitations in developing a U.S.-specific estimate that accurately captures direct and spillover effects on U.S. citizens and residents further demonstrates that it is more appropriate to use a global measure of climate impacts from GHG emissions. The EPA will continue to review developments in the literature, including more robust methodologies for estimating the magnitude of the various damages to U.S. populations from climate impacts and reciprocal international mitigation activities, and explore ways to better inform the public of the full range of GHG impacts.

[42] Another method that has produced estimates of the effect of climate change on U.S.-specific outcomes uses a top-down approach to estimate aggregate damage functions. Published research using this approach include total-economy empirical studies that econometrically estimate the relationship between GDP and a climate variable, usually temperature. As discussed in U.S. EPA (2023) the modeling framework used in the existing published studies using this approach differ in important ways from the inputs underlying the SC-GHG estimates described above (e.g., discounting, risk aversion, and scenario uncertainty) and focus solely on CO_2. Hence, we do not consider this line of evidence in the analysis for this RIA. Updating the framework of total-economy empirical damage functions to be consistent with the methods described in this RIA and U.S. EPA (2023) would require new analysis. Finally, because total-economy empirical studies estimate market impacts, they do not include any non-market impacts of climate change (e.g., heat related mortality) and therefore are also only a partial estimate. EPA will continue to review developments in the literature and explore ways to better inform the public of the full range of GHG impacts.

Chapter 6. Comparison of Costs and Benefits

This section summarizes the total incremental compliance costs (or savings) and the monetized incremental environmental benefits detailed in the sections above to provide an assessment of the total net incremental costs/benefits of requirements contained in the final rule. As described above, abatement costs for the ER&R rule requirements were estimated using EPA's Vintaging Model and MACC methodology, while monetized climate benefits were estimated based on SC-HFC methodology consistent the interim SC-GHG estimates recommended under E.O. 13990. The impact of additional final rule requirements not modeled using the MACC methodology—including cylinder management provisions and recordkeeping and reporting requirements—were then added on in order to estimate the combined costs, benefits, and net benefits of the final rule.

Table 6-1 below provides annual incremental costs, benefits, and net incremental costs of the final rule provisions. As shown, the present value of net incremental benefits is estimated to range from $6.9 billion to $7.5 billion in the base case scenario, using a 3% discount rate for climate benefits[43] and either a 2%, 3%, or 7% discount rate for compliance costs.

Table 6-1: Summary of Annual Incremental Undiscounted Climate Benefits, Costs, and Net Benefits in Base Case Scenario for the 2026–2050 Timeframe (millions of 2022$)[a,b,c,d,e,f]

ER&R Final Rule Impacts – Base Case			
Year	***Incremental Climate Benefits***	***Annual Costs (savings)***	***Net Benefits***
2026	$428	$92	$336
2027	$498	$130	$368
2028	$688	$110	$579
2029	$683	$105	$579
2030	$676	$102	$574
2031	$670	$99	$571
2032	$662	$96	$565
2033	$653	$93	$560
2034	$640	$91	$549
2035	$613	$87	$526
2036	$586	$83	$503
2037	$557	$79	$478
2038	$527	$75	$452
2039	$497	$71	$426
2040	$466	$67	$399
2041	$440	$64	$376

2042	$400	$59			$341		
2043	$364	$55			$309		
2044	$337	$53			$284		
2045	$315	$51			$264		
2046	$298	$51			$246		
2047	$283	$51			$232		
2048	$271	$51			$220		
2049	$264	$51			$213		
2050	$263	$52			$211		
Discount rate	**3%**	**2%**	**3%**	**7%**	**2%**	**3%**	**7%**
PV	$8,356	$1,499	$1,335	$884	$6,857	$7,021	$7,471
EAV	$480	$77	$77	$76	$403	$403	$404

[a] Benefits include only those related to climate. Climate benefits are based on changes (reductions) in HFC emissions and are calculated using four different estimates of the social cost of HFCs (SC-HFCs): model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate. For the presentational purposes of this table, we show the benefits associated with the average SC-HFC at a 3 percent discount rate.
[b] Rows may not appear to add correctly due to rounding.
[c] Present values are calculated using end of year discounting.
[d] The annualized present value of costs and benefits are calculated as if they occur over a 25-year period.
[e] The costs presented in this table are annual estimates.
[f] The PV for the net benefits column is found by taking the difference between the PV of climate benefits at 3 percent and the PV of costs discounted at 7 percent, 3 percent or 2 percent. Because the SC-HFC estimates reflect net climate change damages in terms of reduced consumption (or monetary consumption equivalents), the use of the social rate of return on capital (7 percent under OMB Circular A-4 (2003)) to discount damages estimated in terms of reduced consumption would inappropriately underestimate the impacts of climate change for the purposes of estimating the SC-HFC. See Chapter 5 for more discussion.

Table 6-2 below provides the present value (discounted to 2024) of costs, benefits, and net incremental by type of provision contained in the final rule. Present value for climate benefits is calculated using a 3 percent discount rate, while present value for costs (or saving) is calculated using a 2, 3, and 7 percent discount rate.

Table 6-2: Present Value of Incremental Climate Benefits, Costs, and Net Benefits by type of rule provision in Base Case Scenario for the 2026–2050 Timeframe (millions of 2022$, discounted to 2024)[a,b,c,d]

Provision	Climate Benefits (3%)	Costs (Savings) (2%)	Costs (Savings) (3%)	Costs (Savings) (7%)	Net Benefits 3% Benefits, 2% Costs)	Net Benefits (3% Benefits, 3% Costs)	Net Benefits (3% Benefits, 7% Costs)
Leak Repair And ALD	$6,176	$1,285	$1,146	$760	$4,891	$5,031	$5,417

Fire Suppression	$14	$15	$13	$7	($1)	$1	$7
Cylinder Management	$2,165	($195)	($169)	($101)	$2,360	$2,335	$2,266
Use of Reclaim (servicing)		$43	$38	$23	($43)	($38)	($23)
Recordkeeping & Reporting		$350	$308	$195	($350)	($308)	($195)
RCRA Amendments**	-	$0 to ($40)	$0 to ($35)	$0 to ($22)	$0 to $40	$0 to $35	$0 to $22

*Reclaim requirements may lead to additional emissions reductions by inducing increased recovery of refrigerant at servicing and disposal that may otherwise be released or vented. In our base case scenario, EPA does not estimate an increase in these avoided emissions beyond baseline assumptions.
** RCRA Amendments are not included in the total benefits of this final rule as presented in the text above but are included here for informational purposes.

Chapter 7. Environmental Justice

7.1 Introduction and Background

The environmental justice analyses that were conducted as part of the Allocation Framework Rule RIA and subsequent 2024 Allocation Framework Rule and 2023 Technology Transitions Rule RIA addenda addressed issues associated with the impacts of changes in the production of HFCs and certain substitutes of HFCs on communities near facilities identified as producers of these chemicals. EPA could not identify specific effects of the HFC phasedown or transitions on individual communities, but the Agency did identify ten specific facilities with emissions likely to be affected by these rules. EPA analyzed the demographic characteristics of the fence-line communities in the Census Block Groups within 1-, 3-, 5-, and 10-mile radii of the affected facilities. Please refer to Chapter 6 of the Allocation Framework Rule RIA for an extensive discussion of the environmental justice implications of HFC production and transition.

This chapter provides an analysis of the environmental justice (EJ) implications of this final rule under Subsection (h) of the AIM Act. The information provided in this section of this document is for informational purposes only; EPA is not relying on the information in this section as a record basis for the final action. This analysis is largely similar in approach to that used in the previous EJ analyses, in that it focuses on the baseline environmental conditions in communities proximate to known HFC reclamation facilities which EPA expects may be affected by the final rule.

As discussed in the preamble to this rule, the Subsection (h) Rule proposes to: establish a program for the management of hydrofluorocarbons that includes requirements for leak repair and use of automatic leak detectors for certain equipment containing HFC refrigerants; use of reclaimed HFCs for servicing in certain sectors or subsectors; the servicing, repair, disposal, or installation of fire suppression equipment that contains HFCs; recovery of HFCs from disposable cylinders before discarding; and recordkeeping, reporting, and labeling. EPA is also establishing alternative Resource Conservation and Recovery Act (RCRA) standards for ignitable spent refrigerants being recycled for reuse. The new standards require that ignitable spent refrigerant being recycled for reuse be sent to EPA-certified reclamation facilities.

7.2 Environmental Justice at EPA

Executive Order 12898 (59 FR 7629; February 16, 1994) and Executive Order 14008 (86 FR 7619, January 27, 2021) establish federal executive policy on environmental justice. Executive Order 12898's main provision directs federal agencies, to the greatest extent practicable and permitted by law, to make environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on people of color and low-income populations in the United States. EPA defines environmental justice as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.[44] Executive Order 14008 (86 FR 7619; January 27, 2021) also calls on Agencies to make achieving environmental justice part of their missions "by developing programs, policies, and activities to address the disproportionately high and adverse human health, environmental, climate-related and other cumulative impacts on disadvantaged communities, as well as the accompanying economic challenges of such impacts." It also declares a policy "to secure environmental justice and spur economic opportunity for disadvantaged communities that have been historically marginalized and overburdened by pollution and under-investment in housing, transportation, water and wastewater infrastructure and health care." EPA also released its "Technical Guidance for Assessing Environmental Justice in Regulatory Analysis" (EPA 2016) to provide recommendations that encourage analysts to conduct the highest quality analysis feasible, recognizing that data limitations, time and resource constraints, and analytic challenges will vary by media and circumstance.

As noted in the Allocation Framework Rule RIA, the production and consumption of HFCs is expected to result in changes in the emissions of chemicals which burden communities surrounding HFC production facilities. Because of the limited information regarding how much of each substitute would be produced, which substitutes would be used, and what other factors might affect production and emissions at those locations, it's unclear to what extent baseline risks from hazardous air toxics for communities living near HFC production facilities may be affected. We recognize that communities neighboring facilities that currently produce HFCs and HFC alternatives are often overburdened and disadvantaged. The Agency has a strong interest in mitigating undue burden on underserved communities.

EPA stated its intention in the Allocation Framework Rule to "continue to monitor the impacts of this program on HFC and substitute production, and emissions in neighboring communities, as we move forward to implement this rule" (see 86 FR 55129). EPA will continue to work to address environmental justice and equity concerns for the communities near the facilities identified in this analysis.

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[44] Fair treatment occurs when "no group of people should bear a disproportionate burden of environmental harms and risks, including those resulting from the negative environmental consequences of industrial, governmental, and commercial operations or programs and policies" (U.S. EPA, 2011). Meaningful involvement occurs when "1) potentially affected populations have an appropriate opportunity to participate in decisions about a proposed activity [i.e., rulemaking] that will affect their environment and/or health; 2) the population's contribution can influence [the EPA's] rulemaking decisions; 3) the concerns of all participants involved will be considered in the decision-making process; and 4) [the EPA will] seek out and facilitate the involvement of population's potentially affected by EPA's rulemaking process" (U.S. EPA, 2015). A potential environmental justice concern is defined as "actual or potential lack of fair treatment or meaningful involvement of minority populations, low-income populations, tribes, and indigenous peoples in the development, implementation and enforcement of environmental laws, regulations and policies" (U.S. EPA, 2015). See also https://www.epa.gov/environmentaljustice.

7.3 Environmental Justice Analysis for this Rule

In the Allocation Framework Rule, EPA summarized the public health and welfare effects of GHG emissions (including HFCs), including findings that certain parts of the population may be especially vulnerable to climate change risks based on their characteristics or circumstances, including the poor, the elderly, the very young, those already in poor health, the disabled, those living alone, and/or indigenous populations dependent on one or limited resources due to factors including but not limited to geography, access, and mobility (86 FR 55124 – 55125). Potential impacts of climate change raise environmental justice issues. Low-income communities can be especially vulnerable to climate change impacts because they tend to have more limited capacity to bear the costs of adaptation and are more dependent on climate-sensitive resources such as local water and food supplies. In corollary, some communities of color, specifically populations defined jointly by both ethnic/racial characteristics and geographic location, may be uniquely vulnerable to climate change health impacts in the United States.

As discussed in more detail in the RIA for the Allocation Framework Rule, the environmental justice benefits of reducing climate change are significant. The ER&R rule is expected to result in benefits in the form of reduced GHG emissions, including by reducing the rates of leakage of HFCs to the atmosphere from new and existing equipment. The analysis conducted for this rule also estimates that a portion of these benefits would be incremental to emissions reductions that were anticipated under the Allocation and 2023 Technology Transitions Rules, thus further reducing the risks of climate change.

HFCs are not a local pollutant and have low toxicity to humans. The final rule is expected to result in increased activity at HFC recovery and reclamation facilities. EPA does not anticipate that there are significant increased risks to human health in communities near these facilities due to the presence or potential leakage of the HFCs themselves. It is possible that other chemicals which are potential byproducts of HFC reclamation processes, such as petroleum-based lubricants and waste oils, may be released from these facilities. In addition, the RCRA provisions allow lower flammability spent refrigerants to be sent to HFC recovery and reclamation facilities, potentially increasing the potential for fires at the facilities. To help address the risks posed by fires, the standards include emergency preparedness and response requirements.

For the purposes of this rule, EPA assessed the characteristics of communities near facilities we expect to be affected by this rule (i.e., HFC reclamation facilities). EPA used data from reports required under Section 608 of the Clean Air Act,[45] EPA's Enforcement and Compliance History Online (ECHO)

[45] EPA reviewed Section 608 annual reclamation reports to determine facilities that currently reclaim HFCs and may therefore be expected to continue to do so in the future.

database[46] and information provided by company websites to identify facilities that are active HFC reclaimers. Once reclaim facility locations were identified, EPA retrieved the Facility Registry Service (FRS) IDs for each facility using the Agency's FRS national dataset.[47] EPA derived additional information on the communities surrounding the facilities included in this analysis using data from AirToxScreen 2019 (EPA 2023h) and the Census' American Community Survey 2019 (U.S. Census Bureau 2021). These steps were conducted to facilitate extracting 1) an environmental profile and 2) demographic information within 1, 3, 5 and 10 miles for each facility.

Fenceline communities may be impacted by emissions or chemical releases from facilities of the type identified here, although there is uncertainty about the nature and risks of potential emissions or chemical releases. This analysis notes several limits to our ability to assess the impact this rule on the exposure that specific communities may face:

- The facilities that we identified are diverse, ranging in size from small, boutique facilities that recover and reclaim HFCs for small markets to large chemical production facilities that have several lines of business that may result in atmospheric emissions. EPA does not have information that allows us to distinguish possible fugitive emissions from HFC reclamation and other potential chemical processing or manufacture.
- Many of the communities near the facilities expected to be affected by this rule are also near other sources of toxic emissions which contribute to environmental justice concerns.
- The final rule, and other changes in the HFC reclamation market, would likely result in an overall increase in reclamation, but may result in increases or decreases in the activity at any given facility, or the construction of additional facilities.
- In regard to the effect of the RCRA alternative standards on flammable refrigerants, any potential increase in volumes sent to reclamation facilities would likely be offset by a decrease in volume sent to incineration facilities, or vented illegally.

Due to the limitations of the current data, we cannot make conclusions about the impact of this rule on individuals or specific communities. For the purposes of identifying environmental justice issues; however, it is important to understand the characteristics of the communities surrounding these facilities to better ensure that future actions, as more information becomes available, can improve outcomes. Following the format used for the Allocation Framework Rule RIA, this analysis focuses on information that is available on the demographics and baseline exposure of the communities near these facilities.

[46] EPA's Enforcement and Compliance History Online (ECHO) database was used to verify locations of HFC reclamation facilities (EPA n.d.)
[47] FRS National Data Set available at https://www.epa.gov/frs/epa-frs-facilities-state-single-file-csv-download (EPA 2023h)

7.4 Aggregate Average Characteristics of Communities Near Potentially Affected Production Facilities

The RIA for the Allocation Framework Rule notes that a key issue for evaluating potential for environmental justice concerns is the extent to which an individual might be exposed to feedstock, catalyst, or byproduct emissions from production of HFCs or HFC alternatives. This final rule may result in increases in the numbers of individuals exposed to chemicals in the process of reclaiming and recycling HFCs.

EPA has not undertaken an analysis of how potential emissions from HFC reclamation affect nearby communities. However, a proximity-based approach can identify correlations between the location of these identified reclamation facilities and potential effects on nearby communities. Specifically, this approach assumes that individuals living within a specific distance of an HFC reclamation facility are more likely to be exposed to releases the reclamation process. Those living further away are less likely to be exposed to these releases. Census block groups that are located within 1, 3, 5 and 10 miles of the facility are selected as potentially relevant distances to proxy for exposure. Socioeconomic and demographic data from the American Community Survey 5-year data release for 2019 is used to examine whether a greater percentage of population groups of concern live within a specific distance from a production facility compared to the national average. The national average for rural areas is also presented since four of the nine production facilities expected to be impacted by this rule are classified as rural.[48]

In addition, AirToxScreen data from 2019 for census tracts within and outside of a 1-, 3-, 5- and 10-mile distance are used to approximate the cumulative baseline cancer and respiratory risk due to air toxics exposure for communities near these production facilities. The total cancer risk is reported as the risk per million people if exposed continuously to the specific concentration over an assumed lifetime. The total respiratory risk is reported as a hazard quotient, which is the exposure to a substance divided by the level at which no adverse effects are expected. Both total risk measures are the sum of the individual risk values for all the chemicals evaluated in the AirToxScreen database (EPA 2023h). Note that these risks are not necessarily only associated with a specific HFC production facility. Industrial activity is often concentrated (i.e., multiple plants located within the same geographic area).

[48] The US Census definition of "rural" is used. The term rural is applied to census areas that are not classified as urbanized areas or urban clusters and have a population density below 2,500 people per square mile. Census also looks at other factors before classifying an area as rural including adjacency to an urban area. For the 1-mile radius, population density near an HFC production facility ranges from 40 people per square mile to 306 people per square mile for each of the seven facilities in rural areas. For the 3-mile radius, population density near a facility ranges from 46 people per square mile to 1,262 people per square mile. However, if the majority of census blocks within our buffer are urban-adjacent, we continue to use the overall national or state level average as a basis of comparison (U.S. Census Bureau 2021).

Table 7-1 presents summary information for the demographic data and AirToxScreen risks averaged across the thirty-eight communities near the identified production facilities compared to the overall national average.

The values in the last four columns reflect population-weighted averages across the Census block groups within the specified distance of the facility. While it is not possible to disaggregate the risk information from AirToxScreen by race, ethnicity or income, the overall cancer and respiratory risk in communities within 1, 3, 5 or 10 miles of an identified production facility is does not appear to be markedly greater than either the overall or rural national average.

Table 7-1: Overall Community Profile and 2019 AirToxScreen Risks for Communities Near Identified Facilities

	Overall National Average	***Within 1 mile of reclamation facilities***	***Within 3 miles of reclamation facilities***	***Within 5 miles of reclamation facilities***	***Within 10 miles of reclamation facilities***
% White (race)	72	65	63	62	62
% Black or African American (race)	13	15	16	16	17
% Other (race)	15	19	21	22	21
% Hispanic (ethnic origin)	18	29	29	28	26
Median Household Income (1k 2019$)	71	77	76	75	76
% Below Poverty Line	7.3	7.1	7.5	7.5	7.2
% Below Half the Poverty Line	5.8	5.5	5.7	5.9	5.7
Total Cancer Risk (per million)	26	28	28.6	29	29
Total Respiratory Risk (hazard quotient)	0.31	0.34	0.34	0.35	0.35

Notes: Demographic definitions are as described in the 2019 American Community Survey (U.S. Census Bureau 2021). The "hazard quotient" is defined as the ratio of the potential exposure to a substance and the level at which no adverse effects are expected (calculated as the exposure divided by the appropriate chronic or acute value). A hazard quotient of 1 or lower means adverse noncancer effects are unlikely and, thus, can be considered to have negligible hazard. For HQs greater than one, the potential for adverse effects increases, but we do not know by how much. Total cancer and respiratory risk are drawn from the AirToxScreen database (2019) (EPA 2023h).

Looking across the thirty-eight facilities (Table 7-1), a higher percentage of non-white individuals live in the communities near HFC reclamation facilities compared to the national average. Within one mile of the facilities, the percentage of Black or African Americans is slightly higher than the national average, (15 percent compared to 13 percent) but the percentage increases to 16 percent and 17 percent for the 3 mile and 5 mile, and ten mile distances, respectively. For the communities near these facilities, there are more whose race is identified as "Other," and whose ethnicity is "Hispanic" than the national average. In these communities, the percentage of White residents is higher within one mile of the facilities than farther away. Within one mile, 65 percent of the residents are white, which is lower than the national average of 72 percent.

Median income is generally higher for the communities near these facilities compared to the national average, with the highest median income within the 1-mile radius ($77,000 per year, compared to the national average of $71,000). These communities also generally have similar percentages of low-income households (below the poverty line) and very low-income households (with incomes less than half the poverty line) compared to the national average. The national percentage of households with incomes less than half of the poverty line is 5.8%. Within 1 mile of these specific facilities, the average percentage of households with incomes less than half of the poverty line 5.5 percent. At the 3- and 5-mile distances, the number rises to 5.7 percent and 5.9 percent—it is 5.7 percent in the average 10-mile radius.

For this analysis, we use the 2019 AirToxScreen data for total cancer risk and total respiratory risk. The overall national average total cancer risk using the newest data 26 per million. The Total Respiratory Index average for the nation as a whole is 0.31. The average aggregate risks in communities near these facilities are generally higher than the national averages. The analysis also shows that Total Cancer Risk is higher for those within the 1-mile average radius and increase at the 3-, 5-, and 10-mile radii. While the Total Respiratory index for communities within one mile of these nineteen facilities (.34 compared to the national average of .31) the risk for those closest to the facilities appears smaller than for those at greater distances. The analysis shows that 3-mile, 5-mile, and 10-mile Total Respiratory Risk averages are 0.34, 0.35, and 0.35 respectively.

7.5 Previous Violation and Enforcement Actions

Table 7-2 below provides summary data for facilities identified in the above analysis that are currently registered with one or more EPA compliance regimes under major statutes including CAA, RCRA, and the Clean Water Act (CWA). The table also provides a count of the number of facilities identified within a Native American tribal boundary or located within Census block groups in the 80th or higher national percentile of one of the primary EJ indexes of EJSCREEN, EPA's screening tool for EJ concerns. These data were obtained from EPA's ECHO. Notably, of the 38 facilities included in the above analysis, EPA identified 19 that are currently registered under CAA, RCRA, the National Pollutant Discharge Elimination System (NPDES), and/or CWA compliance regimes.

Table 7-2: Number of facilities falling under one or more environmental compliance regime

Variable	*Description of Variable*	*Count of Identified HFC Reclaim Facilities*
AIR_FLAG	Facility has an Air Facility System (AFS) ID	7

NPDES_FLAG	Facility has a Clean Water Act NPDES ID	5
SDWIS_FLAG	Facility has a Safe Drinking Water Information System (SDWIS) ID	0
RCRA_FLAG	Facility has a Resource Conservation and Recovery Act Information System (RCRAInfo) ID	12
TRI_FLAG	Facility has a Toxics Release Inventory (TRI) ID (most recent reporting year)	2
GHG_FLAG	Facility has a Greenhouse Gas (E-GGRT) ID	0
FAC_INDIAN_CNTRY_FLG	FRS Tribal Code Flag – a Y/N flag indicating whether or not an associated EPA program reported the facility as being within a Native American tribal boundary.	0
FAC_MAJOR_FLAG	Determines if the facility is a designated as a major.	0
FAC_ACTIVE_FLAG	A Y/N flag indicating if any of the associated ICIS-Air, ICIS-NPDES, RCRA or SDWA permits are in an active status.	18
EJSCREEN_FLAG_US	Indicates facilities located in Census block groups in the 80th or higher national percentile of one of the primary environmental justice (EJ) indexes of EJSCREEN, EPA's screening tool for EJ concerns.	7

Source: EPA's Enforcement and Compliance History Online (ECHO). Note: While EPA places a high priority on ensuring the integrity of the national enforcement and compliance databases, some incorrect data may be present due to the large amount of information compiled across multiple streams of data from state, local, and tribal agencies. Known data quality problems are discussed at https://echo.epa.gov/resources/echo-data/known-data-problems (EPA n.d.).

Table 7-3, Table 7-4, and Table 7-5 below provide further information on formal and informal enforcement actions which have occurred at identified facilities within the last 5 years. Out of the 19 facilities, five are registered under CWA, 12 under RCRA, and seven under CAA. Two facilities have recent CWA enforcement violations, as shown in Table 7-3. None of the identified facilities have recent RCRA or CAA enforcement violations.

Table 7-3: Clean Water Act Compliance Status and Recent Enforcement History by Facility

Facility Name	***CWA NPDES Registration***	***CWA Compliance Status***	***Informal Enforcement Actions (last 5 years)***	***Formal Enforcement Actions (last 5 years)***
CERTIFIED REFRIGERANT SERVICES INC	N			
NEWCOMB MECHANICAL INC	N			
ADVANCED REFRIGERANT TECHNOLOGIES, LLC	N			
INSOLUTION KOOL DUCT FABRICATOR	N			
CHILLER SERVICES	N			
J.R.'S APPLIANCE DISPOSAL INC.	N			

Facility Name	CWA NPDES Registration	CWA Compliance Status	Informal Enforcement Actions (last 5 years)	Formal Enforcement Actions (last 5 years)
RECLAIM PA N DELAWARE AVE FAC	Y	Failure to Report DMR - Not Received	4	3
ACS RECLAMATION & RECOVERY INC	N			
REFRIGERANT HANDLING INC	N			
C & M ENTERPRISE OF CHRISTMAS FLORIDA	N			
CJG LLC DBA GOLDEN REFRIGERANT	N			
RECLAMATION TECHNOLOGIES INC	N			
SUMMIT REFRIGERANTS	N			
PERFECT SCORE TOO, LTD	Y	No Violation Identified		
REFRIGERANT RECYCLING INC	Y	No Violation Identified		
A-GAS US	Y	No Violation Identified		
NATIONAL REFRIGERANTS INC	Y	Violation Identified		
HUDSON TECHNOLOGIES CO	N			
TRADEWATER EGV	N			

Source: EPA's Enforcement and Compliance History Online (ECHO). Note: While EPA places a high priority on ensuring the integrity of the national enforcement and compliance databases, some incorrect data may be present due to the large amount of information compiled across multiple streams of data from state, local, and tribal agencies. Known data quality problems are discussed at https://echo.epa.gov/resources/echo-data/known-data-problems (EPA n.d.).

Table 7-4: Resource Recovery and Conservation Act (RCRA) Compliance Status and Recent Enforcement History by Facility

Facility Name	RCRA Registration	RCRA Compliance Status
CERTIFIED REFRIGERANT SERVICES INC	Y	No Violation Identified
NEWCOMB MECHANICAL INC	Y	No Violation Identified
ADVANCED REFRIGERANT TECHNOLOGIES, LLC	N	
INSOLUTION KOOL DUCT FABRICATOR	N	
CHILLER SERVICES	Y	No Violation Identified
J.R.'S APPLIANCE DISPOSAL INC.	Y	No Violation Identified
RECLAIM PA N DELAWARE AVE FAC	Y	No Violation Identified

ACS RECLAMATION & RECOVERY INC	Y	No Violation Identified
REFRIGERANT HANDLING INC	Y	No Violation Identified
C & M ENTERPRISE OF CHRISTMAS FLORIDA	Y	No Violation Identified
CJG LLC DBA GOLDEN REFRIGERANT	Y	No Violation Identified
RECLAMATION TECHNOLOGIES INC	Y	No Violation Identified
SUMMIT REFRIGERANTS	Y	No Violation Identified
PERFECT SCORE TOO, LTD	N	
REFRIGERANT RECYCLING INC	N	
A-GAS US	N	
NATIONAL REFRIGERANTS INC	N	
HUDSON TECHNOLOGIES CO	Y	No Violation Identified
TRADEWATER EGV	N	

Source: EPA's Enforcement and Compliance History Online (ECHO). Note: While EPA places a high priority on ensuring the integrity of the national enforcement and compliance databases, some incorrect data may be present due to the large amount of information compiled across multiple streams of data from state, local, and tribal agencies. Known data quality problems are discussed at https://echo.epa.gov/resources/echo-data/known-data-problems (EPA n.d.).

Table 7-5: Clean Air Act (CAA) Compliance Status and Recent Enforcement History by Facility

Facility Name	***CAA Air Facility System (AFS) Registration***	***CAA Compliance Status***
CERTIFIED REFRIGERANT SERVICES INC	N	
NEWCOMB MECHANICAL INC	N	
ADVANCED REFRIGERANT TECHNOLOGIES, LLC	Y	No Violation Identified
INSOLUTION KOOL DUCT FABRICATOR	Y	No Violation Identified
CHILLER SERVICES	N	
J.R.'S APPLIANCE DISPOSAL INC.	Y	No Violation Identified
RECLAIM PA N DELAWARE AVE FAC	N	
ACS RECLAMATION & RECOVERY INC	N	
REFRIGERANT HANDLING INC	N	
C & M ENTERPRISE OF CHRISTMAS FLORIDA	N	
CJG LLC DBA GOLDEN REFRIGERANT	N	
RECLAMATION TECHNOLOGIES INC	Y	No Violation Identified
SUMMIT REFRIGERANTS	Y	No Violation Identified
PERFECT SCORE TOO, LTD	N	
REFRIGERANT RECYCLING INC	N	
A-GAS US	N	
NATIONAL REFRIGERANTS INC	N	
HUDSON TECHNOLOGIES CO	Y	No Violation Identified
TRADEWATER EGV	Y	No Violation Identified

Source: EPA's Enforcement and Compliance History Online (ECHO). Note: While EPA places a high priority on ensuring the integrity of the national enforcement and compliance databases, some incorrect data may be present due to the large amount of information compiled across multiple streams of data from state, local, and tribal agencies. Known data quality problems are discussed at https://echo.epa.gov/resources/echo-data/known-data-problems (EPA n.d.)

7.6 Conclusion

The provisions in this final rule are expected to result in benefits in the form of reduced GHG emissions. The analysis conducted for the rule also estimates that a portion of these benefits would be incremental to emissions reductions that were anticipated under the Allocation and 2023 Technology Transitions rules, thus further reducing the risks of climate change.

While providing additional overall climate benefits, this rule may also result in changes in emissions of air pollutants or other chemicals which are potential byproducts of HFC reclamation processes at affected facilities. The market for reclaimed HFCs could drive changes in potential risk for communities living near these facilities. However, the nature and location of the emission changes are uncertain. Moreover, there is insufficient information at this time about which facilities will change reclamation processes. The proximity analysis of these communities demonstrates that:

- Total baseline cancer risk and total respiratory risk from air toxics (not all of which stem from HFC reclamation) is generally higher within 1-10 miles of an HFC reclamation facility;
- Higher percentages of low income and very low-income individuals live near HFC reclamation facilities compared to the overall average at the national level;
- Generally, higher percentages of Black or African American individuals live near these facilities;
- Higher percentages of individuals whose race is identified as "Other" live near these facilities;
- Higher percentages of individuals of Hispanic ethnicity live near these facilities;
- It is not clear the extent to which these baseline risks are directly related to HFC reclamation and
- continued analysis of HFC reclamation facilities and associated environmental justice concerns is appropriate.

Given limited information at this time, it is unclear to what extent this rule will impact existing disproportionate adverse effects on communities living near HFC reclamation facilities.[49] The Agency

[49] Statements made in this chapter on the environmental justice concerns of the AIM Act draw support from the following citations: Banzhaf, Spencer, Lala Ma, and Christopher Timmins. 2019. Environmental justice: The economics of race, place, and pollution. Journal of Economic Perspectives; Hernandez-Cortes, D. and Meng, K.C., 2020. Do environmental markets cause environmental injustice? Evidence from California's carbon market (No. w27205). NBER; Hu, L., Montzka, S.A., Miller, B.R., Andrews, A.E., Miller, J.B., Lehman, S.J., Sweeney, C., Miller, S.M., Thoning, K., Siso, C. and Atlas, E.L., 2016. Continued emissions of carbon tetrachloride from the United States nearly two decades after its phaseout for dispersive uses. Proceedings of the National Academy of Sciences; Mansur, E. and Sheriff, G., 2021. On the measurement of environmental inequality: Ranking emissions distributions generated by different policy instruments.; U.S. EPA. 2011. Plan EJ 2014. Washington, DC: U.S. EPA, Office of Environmental Justice.; U.S. EPA. 2015. Guidance on Considering Environmental Justice During the Development of Regulatory Actions. May 2015.; USGCRP. 2016. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. U.S. Global Change Research Program, Washington, DC.

will continue to evaluate the impacts of this final rulemaking on communities with environmental justice concerns and consider further action, as appropriate, to protect health in communities affected by HFC reclamation.

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Appendices:

Appendix A. Underlying Data and Assumptions used to Estimate Costs and Benefits for Leak Repair and Inspection Provisions

The sections below describe the method and assumptions used to estimate aggregate incremental costs and benefits associated with the Agency's final regulations related to leak repair and inspection.

Refrigerant-Containing Equipment Mapping

To develop the scope of appliances affected by the leak inspection and repair requirements of the final rule, EPA utilizes the Vintaging Model. As explained in section 3.2, we divide each end-use within the model into three (low, average, and high) to estimate a range of charge sizes across any single end-use because the model only provides an average charge size. From that distribution, we determine appliance types that are not affected by the leak repair and inspection provisions of the final rule (charge size less than 15 pounds) and divide those that are affected into four groups: sub-small (15 to 50 pound charge size); small (51 to 199 pound charge size); medium (200 to 1,999 pound charge size); and large (2,000 pounds or greater charge size). This mapping for CC, CR, and IPR end-uses is shown in Table A-1.

*Table A-**Error! Bookmark not defined.** - Apportionment of Appliance Types by Charge Size*

Appliance Sector	***Appliance Type*** [a,b]	***Average Charge Size (lbs)***	***Distributed Charge Size Group***	***Charge Size Analyzed (lbs)***	***Equipment Size***
Comfort Cooling	School & Tour Bus AC	11	Low	5	N/A
			Average	11	N/A
			High	16	Sub-small
	Transit Bus AC	16	Low	8	N/A
			Average	16	Sub-small
			High	24	Sub-small
	Passenger Train AC	41	Low	20	Sub-small
			Average	41	Sub-small
			High	61	Small
	CFC-11 Centrifugal Chillers	1,504	Low	752	Medium
			Average	1,504	Medium
			High	2,255	Large

	CFC-12 Centrifugal Chillers	1,566	Low	783	Medium
			Average	1,566	Medium
			High	2,439	Large
	R-500 Chillers	2,012	Low	1,006	Medium
			Average	2,012	Large
			High	3,018	Large
	CFC-114 Chillers	1,389	Low	695	Medium
			Average	1,389	Medium
			High	2,084	Large
	Screw Chillers	661	Low	331	Medium
			Average	661	Medium
			High	992	Medium
	Scroll Chillers	529	Low	265	Medium
			Average	529	Medium
			High	794	Medium
	Reciprocating Chillers	529	Low	265	Medium
			Average	529	Medium
			High	794	Medium
Commercial Refrigeration	Ice Makers[c]	6	Low	3	N/A
			Average	6	N/A
			High	8	N/A
	Modern Rail Transport	17	Low	8	N/A
			Average	17	Sub-small
			High	25	Sub-small
	Vintage Rail Transport	33	Low	17	Sub-small
			Average	33	Sub-small
			High	50	Sub-small
	Road Transport[c]	10	Low	5	N/A
			Average	10	N/A
			High	15	N/A
	Intermodal Containers[c]	10	Low	5	N/A
			Average	10	N/A
			High	15	N/A
	Condensing Unit	47	Low	23	Sub-small
			Average	47	Sub-small
			High	70	Small
	Reefer Ships	1,653	Low	827	Medium
			Average	1,653	Medium
			High	2,480	Large
	Merchant Fishing Transport	388	Low	194	Small
			Average	388	Medium

			High	582	Medium
	CFC-12 Large Retail Food	2,038	Low	1,019	Medium
			Average	2,038	Large
			High	3,057	Large
	R-502 Large Retail Food	2,038	Low	1,019	Medium
			Average	2,038	Large
			High	3,057	Large
	CFC-12 Cold Storage	25,431	Low	12,716	Large
			Average	25,431	Large
			High	38,147	Large
	HCFC-22 Cold Storage	24,220	Low	12,110	Large
			Average	24,220	Large
			High	36,331	Large
	R-502 Cold Storage	24,613	Low	12,306	Large
			Average	24,613	Large
			High	36,919	Large
Industrial Process Refrigeration	CFC-11 Industrial Process Refrigeration	1,945	Low	972	Medium
			Average	1,945	Medium
			High	2,917	Large
	CFC-12 Industrial Process Refrigeration	2,078	Low	1,039	Medium
			Average	2,078	Large
			High	3,117	Large
	HCFC-22 Industrial Process Refrigeration	15,877	Low	7,939	Large
			Average	15,877	Large
			High	23,816	Large

[a] Only end-uses within appliance sectors CC, CR, and IPR are shown.
[b] End-uses with charge sizes less than 10 pounds are not shown as even under the "high" charge size group, they will not be affected by the leak inspection and repair provisions of the rule.
[c]Road Transport and Intermodal Containers average charge sizes are less than 10 pounds but shown as rounded values. Therefore, these appliance types along with Ice Makers are not affected by the leak repair or ALD provisions but are affected by the reclaim provisions.

Cost assumptions

The rule provisions associated with leak repair and inspection are expected to result in:

- **Incremental compliance costs** associated with conducting leak detection/inspections and repairs.
- **Refrigerant savings** associated with detecting and repairing leaks earlier.

Costs and savings were first estimated using a model equipment approach, and then were scaled up industry-wide based on the total number of affected refrigerant-containing appliances using EPA's Vintaging Model (EPA 2023f).

Leak Repair

The final regulation results in incremental compliance costs to owners and operators when leaks in appliances containing 15 or more pounds of refrigerant containing an HFC or a substitute for an HFC that has a GWP above 53 exceed the threshold leak rate. Owners and operators must repair leaks within 30 days, or, under certain circumstances, request an extension to conduct the repair. If leaks cannot be repaired, the appliance must be retrofitted or retired. These requirements are incremental for owners and operators of appliances containing 15 or more pounds of such refrigerant that exceeds the leak rate of 10 percent for CC, 20 percent for CR, or 30 percent for IPR equipment. When leaks are repaired, all appliances must also conduct initial and follow-up verification tests.

Leak repair outcomes. Extending leak rate thresholds to these refrigerant-containing appliances should result in leaks being identified and repaired sooner than previously assumed in the Allocation Rule Reference Case previously evaluated by EPA. This analysis assumes that leaks will be detected and repaired earlier across all CC, CR, and IPR appliances containing 15 pounds or more of HFC refrigerant. Specifically, the analysis assumed that HFC appliances that experience a leak event requiring repair realizes one of three outcomes:

- The **standard repair** outcome conservatively assumes that as a result of the leak rate threshold, repairs are conducted six weeks earlier than they would have been conducted when waiting for the system performance to noticeably change due to refrigerant loss. If the system is using ALD monitoring, repairs are assumed to be conducted ten weeks earlier.
- Under the **extension repair** outcome, owners/operators request an extension for conducting the repair. The analysis conservatively assumes that repairs are also conducted six weeks earlier as a result of the leak repair requirements (or ten weeks earlier if the system is using ALD monitoring). As mentioned above, the extension allows owners/operators additional time to repair an appliance if components cannot be delivered within the necessary time.
- The **retrofit** outcome assumes that systems that require retrofitting are retrofitted 5 years earlier than they would have been in the absence of the final regulations (i.e., five years were assumed to be remaining before normal end-of-life).

Table A-2 Below shows the proportion of affected appliances assumed to experience each outcome.

Table A-1 : Leak Repair Outcomes and Proportions

Outcome	HFC Systems
Standard Repair	98%
Extension Repair	1%
Retrofit	1%

Frequency of repair. Data reported under California's Refrigerant Management Program (RMP) was reviewed to determine an appropriate assumption for the annual frequency of repair for refrigerant-containing appliances that use ALD monitoring systems or are inspected annually or quarterly and are leaking above the threshold annual leak rates in this final action. These data suggest that most appliances with refrigerant charge sizes greater than 50 pounds are repaired once per year, with the exception of larger (>500 pounds) cold storage systems, which are repaired about twice per year on average (CARB 2009a).[50] This analysis assumes that there would be a similar relationship between appliances that are subject to this final rule (under subsection (h) of the AIM Act) as there is for the appliances subject to California's RMP.

Repair effectiveness and baseline leak rates. For all equipment types and sizes, post-repair leak rates reflect California Air Resources Board (CARB) (2009a) estimates, which were based on EPA's Vintaging Model and Intergovernmental Panel on Climate Change (IPCC)/Technology and Economic Assessment Panel (TEAP) (2005) recommendations. The modeled leak rates represent an outcome in which a post-repair leak rate of zero is not achieved. This assumption therefore may be more conservative than what may be actually achieved once this rule is implemented (i.e., this may assume more post-repair leakage than actually occurs). This is because the GWP-weighted amount of emissions prevented by a given leak repair equals the number of weeks divided by 52 weeks per year, multiplied by the difference of the leak rate pre-repair and the leak rate post-repair) multiplied by the charge size multiplied by the GWP of the refrigerant leaking. A higher post-repair leak rate results in a lower change in leak rate, which results in a lower estimate of emissions prevented. On the other hand, some owners and operators may choose to repair the leak to the point where the leak rate does not trigger further leak repair, in which case the assumed non-zero post-repair leak rate may be more reflective of actual industry behavior.

Table A-3 below presents the final leak rate assumptions by equipment sector, type, and size for refrigerant-containing appliances that are affected by the leak repair requirements (i.e., are expected to

[50] Cold storage systems that are repaired twice are assumed to follow a modified standard repair outcome. After the first leak is repaired, the system is assumed to leak for six weeks (without ALD) or 10 weeks (with ALD) at the post-repair leak rate. At that point, the system is assumed to experience a failure such that six weeks (without ALD) or 10 weeks (with ALD) after the original repair the system has leaked a qualifying amount of refrigerant to require a second repair.

leak above the leak rate thresholds).[51] The percentage of each equipment type that is experiencing a qualifying leak was presented earlier in section 3.2 of this document.

Table A-2 : Leak Rate Assumptions by Equipment Sector, Type, and Size

Leak Rate Threshold	Appliance Sector	Equipment Type	Equipment Size	Baseline Annual Leak Rate (for Equipment Requiring Repair)	Annual Post-repair Leak Rate
10%	CC	School & Tour Bus AC	Sub-small	13%	10%
		Transit Bus AC	Sub-small	14%	8%
		Passenger Train AC	Sub-small	10%	2%
		Chiller	Medium	13% – 16%	2%
			Large	14% – 16%	2%
20%	CR	Modern Rail Transport	Sub-small	37%	19%
		Vintage Rail Transport	Sub-small	42%	15%
		Condensing Unit	Sub-small	22%	15%
		Marine Transport	Small	37%	10%
			Medium	29% – 37%	10%
			Large	29%	10%
		Rack	Medium	27%	10%
			Large	27%	10%
		Cold Storage	Large	30% – 34%	10%
30%	IPR	IPR	Medium	43% – 45%	7%
			Large	43% – 45%	7%

Source: EPA (2023f)

Leak Inspection

The final rule would result in incremental compliance costs to appliance owners and operators who would need to conduct leak inspections when leaks are identified that exceed the annual threshold leak rate (i.e., 10% for CC, 20% for CR, or 30% for IPR). For CR and IPR appliances with refrigerant charge sizes between 15 and 500 pounds and for CC and other appliances with charge sizes at or above 15 pounds, leak inspections are annual, and for CR and IPR appliances with refrigerant charge sizes between 500 and 1,500 pounds, leak inspections are quarterly. As a baseline, the cost analysis conservatively assumes that annual leak inspections are not currently performed. This assumption may overestimate compliance costs since some owners and operators have indicated they conduct regular leak inspections to

[51] The average reference case annual leak rates shown in Table A-2 are based on actual leak rate data reported to the CARB RMP. For sub-small equipment, the annual post-repair leak rates are based on the average Vintaging Model leak rate (if lower than the leak rate threshold for the equipment type) or the quintile 1 or quintile 2 leak rate from the modeled leak rate distributions (see Appendix A for more information).

ensure that systems continue to function properly, to avoid recurring refrigerant top-off costs, or they are required to do so based on state regulations. Although the cost analysis assumes no annual leak inspections in the baseline, when estimating baseline emissions, the real-world prevalence of ALD in each subsector is empirically captured in the average leak rates in the Vintaging Model (i.e., unlike costs, emissions are not conservatively estimated, nor are they overestimated due to this assumption). For CR and IPR appliances with refrigerant charge sizes above 1,500 pounds, ALD monitoring is required, so no additional inspections are assumed for these appliances. The incorporation of ALD in the model partially ameliorates the overestimation of costs for leak inspection but does not account for all overestimation due to current leak inspection practices.

Unit Cost and Savings Assumptions

Leak inspection. Leak inspections were assumed to require, on average, four hours per system per inspection for CR and IPR appliances, and two hours for CC appliances.

An hourly labor rate of $58.02 was assumed for leak repair and inspection, based on the mean hourly earnings of $27.63 for the Heating, Air-conditioning, and Refrigeration Mechanics and Installers occupational group (49-9021) from the Bureau of Labor Statistics (BLS 2023a), plus 110 percent to account for overhead ($30.39). All costs in this report are reported in 2022 dollars, unless otherwise noted.

ALD systems. Direct and indirect ALD system costs include the capital expenditure to purchase the hardware (e.g., detector, sensors), plus installation costs and operations and maintenance (O&M) costs associated with annual system maintenance, certification, and data tracking/storage. These costs are assumed to vary by system size (e.g., number of zones and sensors) and are summarized in Table A-4 , with direct ALD systems requiring higher material and installation costs than indirect systems because a separate monitoring device and zone sensors are required (see supplemental analysis [52] titled American Innovation and Manufacturing Act of 2020—Subsection (h): Automatic Leak Detection *Systems* for more information). For the purposes of this analysis, 50 percent of refrigerant-containing appliance owners were assumed to install direct ALD systems and 50 percent of refrigerant-containing appliance owners are assumed to install indirect ALD systems, which offer additional monitoring capabilities that automatically provide certain reporting and recordkeeping requirements. For new CR and IPR refrigerant-containing appliances containing 1,500 pounds or more of refrigerant and installed on or after January 1, 2026, owners or operators are required to purchase and install an ALD system upon installation or within 30

[52] Abt 2024. Available in the docket (EPA-HQ-OAR-2022-0606) for this rulemaking at *https://www.regulations.gov*.

days of installation. By January 1, 2027 owners or operators with existing CR and IPR appliances containing 1,5000 pounds of refrigerant or more that were installed on or after January 1, 2017, and before January 1, 2026, and before January 1, 2026, are required to purchase and install an ALD system. This analysis assumes 10–21 percent of existing and new CR and IPR appliances would already have regularly calibrated ALD systems installed[53], which is assumed to last the full lifetime of the equipment. In subsequent years, new refrigerant-containing appliances entering the market would also experience costs to purchase and install an ALD system. The upfront costs to purchase and install a direct ALD system were annualized over a 5-year period using a rate of 9.8 percent,[54] whereas indirect ALD system owners are not assumed to finance the material and installation costs. Owners and operators were also assumed to experience annual O&M costs throughout the life of the ALD system (Abt, 2024).

Table A-3 : Unit Cost Assumptions for ALD Systems

System Size	Material Cost	Labor Hours	Installation Cost	Equipment and Installation Cost	Annualized Equipment and Installation Cost (Years 1-5)	Annual O&M Cost
Direct ALD System						
1,500–2,000	$9,000	16	$928	$9,928	$2,606	$1,250
2,000+	$9,850	20	$1,160	$11,010	$2,890	$1,440
Indirect ALD System						
1,500-2,000	$2,850	8	$464	$3,314	NA	$950
2,000+	$2,650	10	$580	$3,230	NA	$1,000

Source: (Abt, 2024)

Leak repair. Repair costs are calculated as the base cost of making the repair or retrofit, including labor, parts, refrigerant recovery, and verification tests.[55] These costs are assumed to vary by system size, where leak repairs on a sub-small or small refrigerant-containing appliances are assumed to be relatively simpler and less costly than repairs on medium and large refrigerant-containing appliances. The base costs associated with each outcome were estimated as described below.

[53] This assumes that 10 percent of CR and IPR equipment under 1,500 pounds would have ALD already installed or would be expected to install ALD in the absence of this rulemaking, 16 percent of appliances 1,500–2,000 pounds , and that 21 percent of CR and IPR equipment have ALD as required in California (based on population of California relative to the United States) for appliances greater than 2,000 lb.

[54] Businesses are expected to treat ALD systems as capital assets and therefore it is assumed that businesses would be able to access financing for their purchase, if desired, for a loan tenure of five years. The discount rate used in this analysis is consistent with the RIA to the Allocation Framework Rule, which identified a weighted average cost of capital in this sector of 9.8 percent (EPA 2023a).

[55] Industry input suggested that verification tests are already conducted as standard practice during servicing events. Moreover, because initial and follow-up verification tests can both be conducted during the same service appointment, this requirement is not expected to result in additional servicing events. Time required to conduct the verification tests is included in the estimated time to conduct the repair.

- **Standard repair.** Leak repair costs for a "standard repair" are based on assumptions in CARB (2009a). CARB (2009a) surveyed RACHP service contractors and technicians to validate these cost assumptions. Although the CARB estimates did not cover appliances with charge sizes less than 50 pounds, repair costs for these smaller appliances were extrapolated from the CARB estimates.
- **Extension repair.** An "extension repair" is assumed to involve the repair of a major component such as a compressor and is based on costs presented in Stratus (2009).[56]
- **Retrofit.** Retrofit costs were also based on Stratus (2009); this analysis assumed that the cost to retrofit an entire appliance was between two to three times the cost of the compressor or major component.

As noted above, lower leak rate thresholds will result in leaks being repaired sooner than under the current approach. The analysis assumes that repairs are conducted six or ten weeks earlier as a result of these requirements. Thus, the repair costs attributable to the rule are based on the time cost of conducting those repairs six or ten weeks earlier. The interest cost (at 7 percent, 3 percent, and 2 percent per year) of the base repair cost is attributed to the rule; this cost is referred to below as the "effective cost of repair."[57]

An "effective cost" approach was also taken for the cost of retrofitting. Refrigerant-containing appliances that are retrofitted as a result of the regulation are assumed to be retrofitted five years earlier than they would have been under current practices. Thus, the effective cost of retrofitting attributable to the rule is the cost of borrowing the funds for retrofitting for five years at 7 percent, 3 percent, or 2 percent per year.

Table A-5 below presents the base and effective cost assumptions by repair, appliance charge size, and whether the appliance is using ALD. For retrofit outcomes, the base costs presented do not include the additional cost of replacing the entire refrigerant charge with virgin refrigerant. These costs can be sizable considering, for instance, charge sizes can exceed 10,000 pounds in some systems. For the standard and extension repair outcomes, the cost of refrigerant recharge is not included since it is assumed that the owner or operator would have topped off the system in the absence of the regulatory requirements.

[56] Stratus (2009) obtained estimates of retail prices for typical replacement compressors from a supplier (ThermaCom Ltd.).
[57] CARB used a similar approach—i.e., estimating the effective cost of repair—in developing its economic impact estimates for its High-Global Warming Potential Stationary Source Refrigerant Management Program (CARB 2009b).

Table A-4 : Unit Cost Assumptions for Leak Repair[a,b,c]

Appliance Size	*Total Labor Hours*	*Parts*	*Refrigerant Recovery*	*Total Base Cost for Labor, Parts, and Recovery*	*Effective Cost of Early Repair / Retrofit (without ALD)*			*Effective Cost of Early Re[pair] / Retrofit (with ALD)*		
					7% Discount Rate	*3% Discount Rate*	*2% Discount Rate*	*7% Discount Rate*	*3% Discount Rate*	*2 Dis nt*
Standard Repair										
Sub-small, Small	8	$135	$269	$868	$7.6	$3.3	$2.2	-	-	
Medium	12	$404	$471	$1,572	$13.8	$5.9	$3.9	$22.9	$9.8	$6
Large	16	$808	$876	$2,612	$22.9	$9.8	$6.5	$38.1	$32.7	10
Extension Repair										
Sub-small, Small	20.25	$3,501	$269	$4,945	$43.3	$18.5	$12.4	-	-	
Medium	20.25	$12,768	$471	$14,415	$126	$54.1	$36.0	$210	$90.1	$6
Large	20.25	$12,768	$876	$14,819	$130	$55.6	$37.0	$216	$92.6	$6
Retrofit[c]										
Sub-small, Small	20.25	$10,297	$269	$11,741	$2,616–$2,774	$1,278–$1,355	$881–$935	-	-	
Medium	20.25	$27,459	$471	$29,105	$6,684–$7,837	$3,266–$3,829	$2,252–$2,641	$7,915–$8,173	$3,867–$3,993	$2,–$2,
Large	20.25	$27,459	$876	$29,509	$8,322–$9,214	$4,066–$4,502	$2,804–$3,104	$8,345–$40,352	$4,077–$19,715	$2,–$13

Source: for Standard Repair Labor Hours, Parts, and Recovery Costs: CARB (2009a); for Extension Repair and Retrofit: Stratus (2009).

[a] Assumptions for small appliances were proxied for sub-small equipment containing between 15 and 50 49 pounds of refrigerant.

[b] Total base cost is calculated by multiplying the total labor hours by the labor rate ($58.02) and adding the additional costs associated with parts and refrigerant recovery.

[c] Effective costs for repair and retrofit of appliances varies based on the charge size of the appliance replaced.

Refrigerant savings. By causing leaks to be repaired earlier, the regulations would result in refrigerant cost savings for system operators. Refrigerant cost savings are calculated based on the difference between the baseline and post-repair leak rates, multiplied by the charge size, over the six weeks earlier that each repair was conducted (or ten weeks earlier for appliances using an ALD system). An average price of $4 per pound was assumed for all refrigerants, based on the average price of HFC-134a, R-404A, R-407A and R-507 assumed in the RIA for Phasing Down Production and Consumption of HFCs (EPA 2021).

On a per system basis, effective refrigerant savings range from $0.20 for sub-small school bus AC up to $4,699 for large IPR systems.

Leak repair expected costs and savings. Expected costs and burden reductions per model appliance were estimated on a weighted basis, taking into account the proportion of appliances assumed to reach each leak repair outcome and the unit costs and savings associated with each outcome. Expected costs and savings were estimated in the Vintaging Model in a disaggregated manner, distinguishing between appliance sectors, types, sizes, and refrigerant type (EPA 2023f).

Abatement assumptions

Annual Benefits of Leak Repair and Inspection

Similar to the methodology for estimating costs and savings, benefits were estimated using a model equipment approach. For equipment with 15 or more pounds of refrigerant containing an HFC or a substitute for an HFC that has a GWP above 53, benefits were scaled up industry-wide based on the total number of affected equipment using EPA's Vintaging Model and the approach outlined in Section 3.2.

Benefits are calculated as the refrigerant emissions prevented by repairing or retrofitting a leaking system earlier than would have been done if waiting for the system performance to decline. EPA estimates this to be on average six weeks (or ten weeks if systems are using ALD monitoring). Avoided refrigerant emissions are calculated based on the difference between the baseline and post-repair leak rates (shown in Table A-3 above), multiplied by the charge size, over the six weeks or ten weeks earlier that each repair was conducted. The amount of avoided refrigerant emissions is weighted by an average GWP. For all equipment types, weighted-average GWPs are based on average charge sizes, refrigerant type, and stock of affected equipment modeled in the Vintaging Model (EPA 2023f).

Table A-5 : Average 2026 GWP Assumptions by Equipment Type, Size, and Refrigerant Type

Sector	***Equipment Type***	***Equipment Size***	***Weighted-Average GWP***
CC	School & Tour Bus AC	Sub-Small	1,430
	Transit Bus AC	Sub-small	1,430
	Passenger Train AC	Sub-small	1,602
	Chiller	Medium	1,279 – 1,794
		Large	1,279 – 1,388
CR	Modern Rail Transport	Sub-small	2,676
	Vintage Rail Transport	Sub-small	1,430
	Condensing Unit	Sub-small	3,937
	Marine Transport	Small	3,482
		Medium	2,708 – 3,482
		Large	2,708
	Rack	Medium	2,701
		Large	2,701
	Cold Storage	Large	3,937
IPR	IPR	Medium	1,400 – 1,663
		Large	1,400 – 3,157

Source: EPA (2023f)

The benefits for the extension repair are assumed to be equivalent to the benefits of a standard repair. This analysis does not take into account the additional 30 days (or longer) that the system is leaking between filing the extension and when the actual repair takes place, which could result in overestimating the avoided emissions as a result of the extension request. However, because refrigerant-containing appliances requiring an extension repair have typically more complicated or catastrophic leaks, an extension repair as a result of the regulations would still be taking place earlier than it would under the baseline scenario, and emissions would still be avoided.

Although emission benefits associated with retrofit are anticipated, none are calculated in this analysis. The benefits associated with retrofit fall outside of the one-year timeframe of this analysis (i.e., end users have 30 days to make the initial repair, 30 days to prepare and submit a retrofit plan, and then a full year to complete the retrofit and repair all additional leaks), and thus are not included. Furthermore, because this analysis only considers a one-year period, it does not include benefits from preventing a chronically leaking appliance from continued operation over a longer time period than one year.

On a per appliance basis, effective benefits range from 0.03 metric tons of carbon dioxide (CO_2) equivalent ($MTCO_2eq$) for sub-small school bus AC systems up to 2,503 $MTCO_2eq$ for very large cold storage refrigeration systems (EPA 2023f).

Model Equipment Expected Benefits.

Expected benefits per model equipment were estimated on a weighted basis, taking into account the proportion of appliances assumed to reach each leak repair outcome and the avoided refrigerant emissions associated with each outcome. Expected benefits were estimated in the model in a disaggregated manner, distinguishing between equipment sectors, types, sizes, and refrigerant type. The expected avoided refrigerant emissions per model equipment type (as described above) were multiplied by the number of each type of equipment assumed to experience leaks above the rule's threshold leak rates (see section 3.2). This yields aggregate benefits for the United States as a whole as shown in Table A-7 below (EPA 2023f).

Table A-6 : Expected Emissions Reductions in 2026 by Equipment Type and Size

Sector	***Equipment Type***	***Equipment Size***	***GHG Emissions Avoided ($MTCO_2eq$)***
CC	School & Tour Bus AC	Sub-small	3,100
	Transit Bus AC	Sub-small	1,900
	Passenger Train AC	Sub-small	1,100
	Chiller	Medium	724,200
		Large	27,500

CR	Modern Rail Transport	Sub-small	1,400
	Vintage Rail Transport	Sub-small	1,900
	Condensing Unit	Sub-small	77,800
	Marine Transport	Small	75,700
		Medium	386,300
		Large	8,300
	Rack	Medium	876,000
		Large	913,400
	Cold Storage	Large	163,700
IPR	IPR	Medium	59,500
		Large	2,065,800

Future Annual Benefits of Leak Repair and Inspection

The analysis described above estimates one-year benefits based on the current distribution of HFC appliances in use. However, because the use of HFCs will change over the next decade due to the phase-down of HFCs in accordance with the AIM Act 2024 Allocation Rule, benefits for the requirements of this rule will also change. Future benefits were estimated using a model equipment, facility, and entity approach. Benefits were then scaled up industry-wide based on the total number of affected appliances anticipated in 2030, 2040, and 2050.

Several assumptions were made to simplify the process of determining the number of affected appliances and the benefits of leak repair in 2030, 2040, and 2050:

- Appliances used in later years are assumed to have the same leak rates and refrigerant charge sizes as those in the 2026 baseline scenario.
- The same proportion of standard repairs, extension repairs, and retrofits are assumed for all years.
- The affected HFC appliances in 2026 are assumed to grow according to the growth rate, lifetime, and transitions in EPA's Vintaging Model—with the adjustments described below.

The growth in stock of HFC appliances was adjusted to account for the Allocation Framework rule, the 2024 Allocation Rule RIA addendum, and the 2023 Technology Transitions RIA addendum. Benefits from the transition away from HFCs were quantified and recently presented in the RIA addendum for the EPA final rulemaking, *Regulatory Impact Analysis Addendum: Impact of the Technology Transitions Rule* (EPA 2023b). To avoid double-counting benefits, this analysis assumes that HFC CR, CC, and IPR appliances begin transitioning away from HFCs in accordance with the transition scenario presented in the 2023 Technology Transitions RIA Addendum.[58]

[58] Different types of appliances are assumed to transition in different years as presented in the 2023 Technology Transitions Rule RIA Addendum (EPA 2023b).

Appliance-specific average GWP values were also updated to reflect the specific mix of HFC refrigerants assumed in 2030, 2040, and 2050, as shown in Table A-8 . GWP values in 2030, 2040, and 2050 include HFCs and substitutes such as HFOs and HCFOs, but did not include other substitutes such as CO_2, ammonia, or hydrocarbons.[59] Affected equipment modeled in EPA's Vintaging Model, which was the basis for the RIA analysis for the AIM Allocation Framework Rule and the RIA Addendum for the 2024 Allocation Rule, were distributed into three size categories (as discussed in section 3.2) and therefore all size categories for some equipment types have the same weighted-average GWP.

Table A-7 : Average GWP Assumptions by Equipment Type, Size, and Refrigerant Type for 2030, 2040, and 2050

Sector	***Equipment Type***	***Equipment Size***	***Weighted-Average GWP***		
			2030	***2040***	***2050***
CC	School & Tour Bus AC	Sub-small	1,430	1,430	1,430
	Transit Bus AC	Sub-small	1,430	1,430	1,430
	Passenger Train AC	Sub-small	1,602	1,602	1,602
	Unitary AC	Sub-small	1,717	836	730
	Chiller	Medium	1,122 – 1,832	716 – 1,887	0 – 698
		Large	1,122 – 1,182	716 – 896	618 – 625
CR	Modern Rail Transport	Sub-small	2,676	2,676	2,676
	Vintage Rail Transport	Sub-small	1,430	-	-
	Condensing Unit	Sub-small	3,937	3,937	-
	Marine Transport	Small	3,274	2,817	2,431
		Medium			
		Large	2,554 – 3,274	2,242 – 2,817	1,957 – 2,431
	Rack	Medium	2,554	2,242	1,957
		Large	2,510	2,417	-
	Cold Storage	Large	2510	2417	-
IPR	IPR	Medium	3,937	3,937	-
		Large	1,340 – 1,639	1,078 – 1,442	485 – 517

Benefits on a per-appliance basis were then calculated in the same manner outlined in above and were multiplied by the estimated affected appliances in 2030, 2040, and 2050 described above as shown in Table A-9.

Table A-8 : Expected Emissions Reductions by Equipment Type, Size, and Refrigerant Type for 2030, 2040, and 2050

Sector	***Equipment Type***	***Equipment Size***	***MTCO2eq***		
			2030	***2040***	***2050***

[59] Given the GWPs of HFOs, HCFOs, CO_2, ammonia, and hydrocarbons are very low compared to regulated HFCs, the is not expected to affect the weighted-average GWP significantly.

CC	School & Tour Bus AC	Sub-small	3,300	3,800	4,100
CC	Transit Bus AC	Sub-small	2,000	2,300	2,500
CC	Passenger Train AC	Sub-small	1,200	1,300	1,400
CC	Chiller	Medium	678,200	324,200	197,700
CC	Chiller	Large	25,200	19,500	14,700
CR	Modern Rail Transport	Sub-small	1,500	1,600	1,700
CR	Vintage Rail Transport	Sub-small	800	-	-
CR	Condensing Unit	Sub-small	64,700	19,900	-
CR	Marine Transport	Small	86,900	95,200	92,700
CR	Marine Transport	Medium	445,500	488,800	476,100
CR	Marine Transport	Large	12,400	14,900	14,600
CR	Rack	Medium	752,200	174,000	-
CR	Rack	Large	840,300	200,800	-
CR	Cold Storage	Large	197,900	82,700	-
IPR	IPR	Medium	52,200	26,800	3,500
IPR	IPR	Large	2,463,100	1,559,000	111,100

Note: By 2040, there are no longer any HFC refrigerants assumed in vintage rail transport systems. By 2050, there are no longer any HFC refrigerants assumed in condensing units, cold storage, and rack systems.

Appendix B. Vintaging Model Leak Rate Distributions

The Vintaging Model simulates equipment emissions and consumption using average leak rates, consistent with *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC 2006). These average leak rates represent the full spectrum of potential equipment leak events, in which equipment may experience negligible or more significant and/or catastrophic leaks. In order to simulate a more real-world distribution of leak rates, equipment stock was distributed into quintiles, each containing 20 percent of units, where the leak rate distributions equal the weighted average leak rate modeled in the Vintaging Model for each equipment type. The representative leak rate for each quintile was estimated such that each subsector has at least 20 percent of its stock (i.e., one quintile) above the threshold leak rate.

Table B-1 summarizes the leak rate distributions for equipment containing 15 or more pounds of refrigerant considered in the analysis.

For most subsectors, the quintiles were established in increments of 25% percent above or below the average leak rate (i.e., quintile 1 is 50 percent below, quintile 2 is 25 percent below, quintile 3 is the average, quintile 4 is 25 percent above, and quintile 5 is 50 percent above). However, for some subsectors, the average leak rate modeled in the Vintaging Model was significantly below the threshold leak rate, such that the upper quintile leak rate did not exceed the threshold leak rate. In those cases, the fifth quintile leak rate was set to be significantly higher than the average leak rate to ensure that each subsector had some portion of equipment stock above the leak rate threshold and therefore was affected by the final rulemaking. In those cases, the quintile 1 through 4 values were also manipulated such that the weighted average leak rate across all five quintiles still equaled the average leak rate (i.e., quintile 3).[60]

Table B-1 : Leak Rate Distributions for Refrigerant-Containing Appliances

Sector	Equipment Type	Vintaging Model Subsector[a]		Quintile					Average Leak Rate
				1	2	3	4	5	
Subsectors with charge sizes greater than 15 pounds									
CC	Passenger Train AC	Passenger Train AC	% Relative to Average	0.88	1.1	1.4	1.6	495	2.1
			Assumed Leak Rate (%)	0.018	0.023	0.029	0.034	10[b]	
CC	School & Tour Bus AC	School & Tour Bus AC[c]	% Relative to Average	50	75	100	125	150	10
			Assumed Leak Rate (%)	4.8	7.2	10	12	14	
CR	Rail Transport	Vintage Rail Transport	% Relative to Average	25	50	100	150	175	36
			Assumed Leak Rate (%)	15	24	36	48	57	
CR	Condensing Unit	HCFC-22 Large Condensing Units (Medium Retail Food)	% Relative to Average	50	75	100	125	150	15
			Assumed Leak Rate (%)	6.5	11	15	19	23	
CC	Transit Bus AC	Transit Bus AC	% Relative to Average	50	75	100	125	150	10
			Assumed Leak Rate (%)	5	7.5	10	12	15	
CR	Rail Transport	Modern Rail Transport	% Relative to Average	50	75	100	125	150	33
			Assumed Leak Rate (%)	17	25	33	41	50	
CC	Chiller	CFC-11 Centrifugal Chillers[d]	% Relative to Average	0	0	0	0	850	3.2
			Assumed Leak Rate (%)	0	0	0	0	16	
CC	Chiller	CFC-12 Centrifugal Chillers[d]	% Relative to Average	0	0	0	0	700	2.8
			Assumed Leak Rate (%)	0	0	0	0	14	
CC	Chiller	R-500 Chillers[d]	% Relative to Average	0	0	0	0	700	2.8
			Assumed Leak Rate (%)	0	0	0	0	14	
CC	Chiller	CFC-114 Chillers[d]	% Relative to Average	0	0	0	0	750	3.0
			Assumed Leak Rate (%)	0	0	0	0	15	

[60] Because the average Vintaging Model leak rate for certain subsectors (e.g., chillers, IPR) are significantly lower than the threshold leak rates of 10% for comfort cooling and 30% for IPR, it is not possible for the weighted average leak rate across the quintiles to equal the average leak rate using the percentages above.

Sector	Equipment Type	Vintaging Model Subsector[a]		Quintile 1	2	3	4	5	Average Leak Rate
CC	Chiller	Screw Chillers[d]	% Relative to Average	0	0	0	0	1300	2.6
			Assumed Leak Rate (%)	0	0	0	0	13	
CC	Chiller	Scroll Chillers[d]	% Relative to Average	0	0	0	0	1300	2.6
			Assumed Leak Rate (%)	0	0	0	0	13	
CC	Chiller	Reciprocating Chillers[d]	% Relative to Average	0	0	0	0	850	2.6
			Assumed Leak Rate (%)	0	0	0	0	13	
IPR	IPR	CFC-11 Industrial Process Refrigeration[d]	% Relative to Average	0	0	0	0	850	8.5
			Assumed Leak Rate (%)	0	0	0	0	43	
IPR	IPR	CFC-12 Industrial Process Refrigeration[d]	% Relative to Average	0	0	0	0	1250	9.0
			Assumed Leak Rate (%)	0	0	0	0	45	
IPR	IPR	HCFC-22 Industrial Process Refrigeration	% Relative to Average	0	0	0	0	500	8.6
			Assumed Leak Rate (%)	0	0	0	0	43	
CR	Cold Storage	CFC-12 Cold Storage	% Relative to Average	0	50	75	100	275	12
			Assumed Leak Rate (%)	0	6.1	9.2	12	34	
CR	Cold Storage	HCFC-22 Cold Storage	% Relative to Average	0	50	75	100	275	11
			Assumed Leak Rate (%)	0	5.5	8.3	11	30	
CR	Cold Storage	R-502 Cold Storage	Assumed Leak Rate (%)	0	50	75	100	275	11
			% Relative to Average	0	5.6	8.4	11	31	
CR	Rack	CFC-12 Large Retail Food	Assumed Leak Rate (%)	50	75	100	125	150	22
			% Relative to Average	11	16	22	27	32	
CR	Rack	R-502 Large Retail Food	Assumed Leak Rate (%)	50	75	100	125	150	22
			Assumed Leak Rate (%)	11	16	22	27	32	
CR	Marine Transport	Merchant Fishing Transport	% Relative to Average	50	75	100	125	150	33
			Assumed Leak Rate (%)	17	25	33	41	50	
CR	Marine Transport	Reefer Ships	% Relative to Average	50	75	100	125	150	23
			Assumed Leak Rate (%)	12	17	23	29	35	

Sector	Equipment Type	Vintaging Model Subsector[a]	Quintile 1	2	3	4	5	Average Leak Rate

Note: Values may not sum due to independent rounding

[a] Vintaging Model subsectors are often defined by the ODS that was original used, as that affects the transition choices. This analysis does not consider the effects the final rule may have on ODS emissions.

[b] The assumed leak rate percentages for this equipment type quintile exceeds the 10 percent threshold rate for comfort cooling systems, but is shown as equal to 10 percent due to rounding.

[c] 33 percent of units in the School & Tour Bus AC sector are modeled with a charge size above 15 lbs.

[d] The average leak rate modeled does not equal the average leak rate for these subsectors in the Vintaging Model.

Althought the leak inspection and repair provisions only apply to refrigerant-containing appliances with a charge size of 15 pounds or greater, the requirement to use reclaimed refrierant applies to a few subsectors that have smaller charge sizes. The leak rate distribution for these subsectors are shown in Table B-2.

Table B-2: Leak Rate Distributions for Additional Refrigerant-Containing Appliances

Sector	Equipment Type	Vintaging Model Subsector		Quintile 1	2	3	4	5	Average Leak Rate
Subsectors with charge sizes less than 15 pounds									
IPR	Ice Makers	Ice Makers[a]	% Relative to Average	15	30	45	60	350	3.0
			Assumed Leak Rate (%)	0.45	0.90	1.4	1.8	11	
CR	Road Transport	Road Transport	% Relative to Average	50	75	100	125	150	33
			Assumed Leak Rate (%)	17	25	33	41	50	
CR	Intermodal Containers	Intermodal Containers	% Relative to Average	50	75	100	125	150	21
			Assumed Leak Rate (%)	10	16	21	26	31	

[a] The average leak rate modeled does not equal the average leak rate for these subsectors in the Vintaging Model.

Appendix C. Detailed Costs by Equipment – Leak Repair and Inspection

Table C-1: Total Annual Refrigerant Savings in 2030 (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate by Equipment Type

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate		2% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2030	2030	2030	2030	2030	2030	2030
Leak Repair			**-$20,873,100**	**$19,963,000**	**-$910,100**	**$9,509,100**	**-$11,364,000**	**$6,517,600**	**-$14355500**
CC	School & Tour Bus AC	Sub-Small	-$20,700	$2,400,800	$2,380,100	$1,139,800	$1,119,100	$780,600	$759,900
	Transit Bus AC	Sub-Small	-$12,400	$850,500	$838,100	$403,800	$391,400	$276,500	$264,100
	Train AC	Sub-Small	-$6,500	$132,700	$126,200	$63,000	$56,500	$43,200	$36,700
	Chiller	Medium	-$4,100,500	$7,985,200	$3,884,700	$3,817,700	-$282,800	$2,619,000	-$1,481,500
	Chiller	Large	-$192,000	$140,900	-$51,100	$67,000	-$125,000	$45,900	-$146,100
CR	Modern Rail Transport[a]	Sub-Small	-$5,400	$108,000	$102,600	$51,300	$45,900	$35,100	$29,700
	Condensing Unit	Sub-Small	-$146,400	$2,903,400	$2,757,000	$1,378,700	$1,232,300	$944,300	$797,900
	Vintage Rail Transport[a]	Sub-Small	-$5,600	$40,300	$34,700	$19,200	$13,600	$13,100	$7,500
	Rack[a]	Medium	-$2,936,100	$1,648,800	-$1,287,300	$782,300	-$2,153,800	$535,700	-$2,400,400
	Rack[a]	Large	-$3,280,300	$1,023,800	-$2,256,500	$483,900	-$2,796,400	$331,000	-$2,949,300
	Marine Transport[a]	Small	-$260,200	$318,800	$58,600	$151,500	-$108,700	$103,800	-$156,400
	Marine Transport[a]	Medium	-$1,342,500	$1,518,300	$175,800	$725,900	-$616,600	$498,000	-$844,500
	Marine Transport[a]	Large	-$47,600	$15,300	-$32,300	$7,200	-$40,400	$4,900	-$42,700
	Cold Storage	Large	-$233,500	$39,500	-$194,000	$18,800	-$214,700	$12,900	-$220,600

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate		2% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2030	2030	2030	2030	2030	2030	2030
IPR	IPR	Medium	-$284,900	$127,300	-$157,600	$60,900	-$224,000	$41,800	-$243,100
	IPR	Large	-$7,998,500	$709,400	-$7,289,100	$338,100	-$7,660,400	$231,800	-$7,766,700
Leak Inspection			**$0**	**$73,942,500**	**$73,942,500**	**$73,942,500**	**$73,942,500**	**$73,942,500**	**$73,942,500**
CC	School & Tour Bus AC	Sub-Small	$0	$8,195,200	$8,195,200	$8,195,200	$8,195,200	$8,195,200	$8,195,200
	Transit Bus AC	Sub-Small	$0	$2,903,400	$2,903,400	$2,903,400	$2,903,400	$2,903,400	$2,903,400
	Train AC	Sub-Small	$0	$450,200	$450,200	$450,200	$450,200	$450,200	$450,200
	Chiller	Medium	$0	$10,755,700	$10,755,700	$10,755,700	$10,755,700	$10,755,700	$10,755,700
	Chiller	Large	$0	$147,900	$147,900	$147,900	$147,900	$147,900	$147,900
CR	Modern Rail Transport[a]	Sub-Small	$0	$736,900	$736,900	$736,900	$736,900	$736,900	$736,900
	Condensing Unit	Sub-Small	$0	$19,665,500	$19,665,500	$19,665,500	$19,665,500	$19,665,500	$19,665,500
	Vintage Rail Transport[a]	Sub-Small	$0	$273,900	$273,900	$273,900	$273,900	$273,900	$273,900
	Rack[a]	Medium	$0	$10,881,300	$10,881,300	$10,881,300	$10,881,300	$10,881,300	$10,881,300
	Rack[a]	Large	$0	$3,545,700	$3,545,700	$3,545,700	$3,545,700	$3,545,700	$3,545,700
	Marine Transport[a]	Small	$0	$2,069,900	$2,069,900	$2,069,900	$2,069,900	$2,069,900	$2,069,900
	Marine Transport[a]	Medium	$0	$10,520,000	$10,520,000	$10,520,000	$10,520,000	$10,520,000	$10,520,000
	Marine Transport[a]	Large	$0	$50,500	$50,500	$50,500	$50,500	$50,500	$50,500
	Cold Storage	Large	$0	$35,800	$35,800	$35,800	$35,800	$35,800	$35,800
IPR	IPR	Medium	$0	$1,338,300	$1,338,300	$1,338,300	$1,338,300	$1,338,300	$1,338,300
	IPR	Large	$0	$2,372,300	$2,372,300	$2,372,300	$2,372,300	$2,372,300	$2,372,300
Automatic Leak Detection			**$0**	**$26,491,300**	**$26,491,300**	**$26,491,300**	**$26,491,300**	**$26,491,300**	**$26,491,300**
CC	School & Tour Bus AC	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Transit Bus AC	Sub-Small	$0	$0	$0	$0	$0	$0	$0

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate: Incremental Compliance Costs	7% Discount Rate: Combined Annual Savings and Compliance Costs	3% Discount Rate: Incremental Compliance Costs	3% Discount Rate: Combined Annual Savings and Compliance Costs	2% Discount Rate: Incremental Compliance Costs	2% Discount Rate: Combined Annual Savings and Compliance Costs
			2030	**2030**	**2030**	**2030**	**2030**	**2030**	**2030**
	Train AC	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Chiller	Medium	$0	$0	$0	$0	$0	$0	$0
	Chiller	Large	$0	$0	$0	$0	$0	$0	$0
CR	Modern Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Condensing Unit	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Vintage Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Rack[a]	Medium	$0	$7,725,900	$7,725,900	$7,725,900	$7,725,900	$7,725,900	$7,725,900
	Rack[a]	Large	$0	$7,725,900	$7,725,900	$7,725,900	$7,725,900	$7,725,900	$7,725,900
	Marine Transport[a]	Small	$0	$0	$0	$0	$0	$0	$0
	Marine Transport[a]	Medium	$0	$172,800	$172,800	$172,800	$172,800	$172,800	$172,800
	Marine Transport[a]	Large	$0	$188,300	$188,300	$188,300	$188,300	$188,300	$188,300
	Cold Storage	Large	$0	$447,700	$447,700	$447,700	$447,700	$447,700	$447,700
IPR	IPR	Medium	$0	$0	$0	$0	$0	$0	$0
	IPR	Large	$0	$10,230,700	$10,230,700	$10,230,700	$10,230,700	$10,230,700	$10,230,700
Reporting & Recordkeeping			**$0**	**$10,770,884**	**$10,770,884**	**$10,770,884**	**$10,770,884**	**$10,770,884**	**$10,770,884**
CC, CR, and IPR	CC and CR 15–50 lb.	15-50	$0	$6,115,317	$6,115,317	$6,115,317	$6,115,317	$6,115,317	$6,115,317
	CC, CR, and IPR ≥50 lb.	50+	$0	$4,655,567	$4,655,567	$4,655,567	$4,655,567	$4,655,567	$4,655,567
Total			**-$20,873,100**	**$131,167,684**	**$110,294,584**	**$120,713,784**	**$99,840,684**	**$117,722,284**	**$96,849,184**

Totals may not sum due to independent rounding.

[a] The costs and savings for Modern Rail Transport, Vintage Rail Transport, Rack, and Marine Transport reflect the requirements to use reclaimed material starting in 2029.

Table C-2: Total Annual Refrigerant Savings in 2040 (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate by Equipment Type

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate		2% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2040	2040	2040	2040	2040	2040	2040
Leak Repair			**-$12,790,700**	**$13,708,900**	**$918,200**	**$6,531,600**	**-$6,259,100**	**$4,476,900**	**-$8,313,800**
CC	School & Tour Bus AC	Sub-Small	-$23,600	$2,731,800	$2,708,200	$1,296,900	$1,273,300	$888,200	$864,600
	Transit Bus AC	Sub-Small	-$14,100	$967,700	$953,600	$459,400	$445,300	$314,600	$300,500
	Train AC	Sub-Small	-$7,200	$145,400	$138,200	$69,100	$61,900	$47,300	$40,100
	Chiller	Medium	-$2,984,500	$5,210,500	$2,226,000	$2,490,600	-$493,900	$1,708,500	-$1,276,000
	Chiller	Large	-$204,000	$149,600	-$54,400	$71,200	-$132,800	$48,800	-$155,200
CR	Modern Rail Transport[a]	Sub-Small	-$5,700	$115,600	$109,900	$54,900	$49,200	$37,600	$31,900
	Condensing Unit	Sub-Small	-$45,100	$893,900	$848,800	$424,500	$379,400	$290,700	$245,600
	Vintage Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Rack[a]	Medium	-$705,500	$366,600	-$338,900	$173,600	-$531,900	$118,800	-$586,700
	Rack[a]	Large	-$814,000	$230,800	-$583,200	$108,700	-$705,300	$74,300	-$739,700
	Marine Transport[a]	Small	-$331,200	$405,700	$74,500	$192,900	-$138,300	$132,100	-$199,100
	Marine Transport[a]	Medium	-$1,711,400	$1,932,200	$220,800	$923,800	-$787,600	$633,700	-$1,077,700
	Marine Transport[a]	Large	-$65,300	$19,800	-$45,500	$9,300	-$56,000	$6,400	-$58,900
	Cold Storage	Large	-$96,500	$16,500	-$80,000	$7,800	-$88,700	$5,400	-$91,100
IPR	IPR	Medium	-$167,100	$74,700	-$92,400	$35,800	-$131,300	$24,500	-$142,600
	IPR	Large	-$5,615,500	$448,100	-$5,167,400	$213,100	-$5,402,400	$146,000	-$5,469,500
Leak Inspection			**$0**	**$47,214,200**	**$47,214,200**	**$47,214,200**	**$47,214,200**	**$47,214,200**	**$47,214,200**

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate		2% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2040	2040	2040	2040	2040	2040	2040
CC	School & Tour Bus AC	Sub-Small	$0	$9,325,000	$9,325,000	$9,325,000	$9,325,000	$9,325,000	$9,325,000
	Transit Bus AC	Sub-Small	$0	$3,303,700	$3,303,700	$3,303,700	$3,303,700	$3,303,700	$3,303,700
	Train AC	Sub-Small	$0	$493,300	$493,300	$493,300	$493,300	$493,300	$493,300
	Chiller	Medium	$0	$6,949,600	$6,949,600	$6,949,600	$6,949,600	$6,949,600	$6,949,600
	Chiller	Large	$0	$157,000	$157,000	$157,000	$157,000	$157,000	$157,000
CR	Modern Rail Transport[a]	Sub-Small	$0	$788,700	$788,700	$788,700	$788,700	$788,700	$788,700
	Condensing Unit	Sub-Small	$0	$6,054,800	$6,054,800	$6,054,800	$6,054,800	$6,054,800	$6,054,800
	Vintage Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Rack[a]	Medium	$0	$1,992,300	$1,992,300	$1,992,300	$1,992,300	$1,992,300	$1,992,300
	Rack[a]	Large	$0	$398,500	$398,500	$398,500	$398,500	$398,500	$398,500
	Marine Transport[a]	Small	$0	$2,634,200	$2,634,200	$2,634,200	$2,634,200	$2,634,200	$2,634,200
	Marine Transport[a]	Medium	$0	$13,365,200	$13,365,200	$13,365,200	$13,365,200	$13,365,200	$13,365,200
	Marine Transport[a]	Large	$0	$41,900	$41,900	$41,900	$41,900	$41,900	$41,900
	Cold Storage	Large	$0	$13,100	$13,100	$13,100	$13,100	$13,100	$13,100
IPR	IPR	Medium	$0	$785,700	$785,700	$785,700	$785,700	$785,700	$785,700
	IPR	Large	$0	$911,200	$911,200	$911,200	$911,200	$911,200	$911,200
Automatic Leak Detection			**$0**	**$17,473,700**	**$17,473,700**	**$17,473,700**	**$17,473,700**	**$17,473,700**	**$17,473,700**
CC	School & Tour Bus	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Transit Bus AC	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Train AC	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Chiller	Medium	$0	$0	$0	$0	$0	$0	$0
	Chiller	Large	$0	$0	$0	$0	$0	$0	$0

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate		2% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2040	2040	2040	2040	2040	2040	2040
CR	Modern Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Condensing Unit	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Vintage Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Rack[a]	Medium	$0	$2,764,700	$2,764,700	$2,764,700	$2,764,700	$2,764,700	$2,764,700
	Rack[a]	Large	$0	$2,764,700	$2,764,700	$2,764,700	$2,764,700	$2,764,700	$2,764,700
	Marine Transport[a]	Small	$0	$0	$0	$0	$0	$0	$0
	Marine Transport[a]	Medium	$0	$261,500	$261,500	$261,500	$261,500	$261,500	$261,500
	Marine Transport[a]	Large	$0	$290,700	$290,700	$290,700	$290,700	$290,700	$290,700
	Cold Storage	Large	$0	$202,300	$202,300	$202,300	$202,300	$202,300	$202,300
IPR	IPR	Medium	$0	$0	$0	$0	$0	$0	$0
	IPR	Large	$0	$11,189,800	$11,189,800	$11,189,800	$11,189,800	$11,189,800	$11,189,800
Reporting & Recordkeeping			**$0**	**$7,860,124**	**$7,860,124**	**$7,860,124**	**$7,860,124**	**$7,860,124**	**$7,860,124**
CC, CR, and IPR	CC and CR 15–50 lb.	15-50	$0	$4,629,656	$4,629,656	$4,629,656	$4,629,656	$4,629,656	$4,629,656
	CC, CR, and IPR ≥50 lb.	50+	$0	$3,230,469	$3,230,469	$3,230,469	$3,230,469	$3,230,469	$3,230,469
Total			**-$12,790,700**	**$86,256,924**	**$73,466,224**	**$79,079,624**	**$66,288,924**	**$77,024,924**	**$64,234,224**

Totals may not sum due to independent rounding.

[a] The costs and savings for Modern Rail Transport, Vintage Rail Transport, Rack, and Marine Transport reflect the requirements to use reclaimed material starting in 2029.

Table C-3: Total Annual Refrigerant Savings in 2050 (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate by Equipment Type

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate		2% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2050	2050	2050	2050	2050	2050	2050
Leak Repair			**-$7,068,700**	**$11,896,900**	**$4,828,200**	**$5,670,700**	**-$1,398,000**	**$3,887,400**	**-$3,181,300**
CC	School & Tour Bus AC	Sub-Small	-$25,600	$2,959,500	$2,933,900	$1,405,000	$1,379,400	$962,200	$936,600
CC	Transit Bus AC	Sub-Small	-$15,300	$1,048,400	$1,033,100	$497,700	$482,400	$340,900	$325,600
CC	Train AC	Sub-Small	-$7,800	$157,500	$149,700	$74,800	$67,000	$51,200	$43,400
CC	Chiller	Medium	-$2,709,700	$4,629,300	$1,919,600	$2,212,700	-$497,000	$1,517,900	-$1,191,800
CC	Chiller	Large	-$210,800	$154,700	-$56,100	$73,600	-$137,200	$50,400	-$160,400
CR	Modern Rail Transport[a]	Sub-Small	-$6,200	$125,200	$119,000	$59,400	$53,200	$40,700	$34,500
CR	Condensing Unit	Sub-Small	$0	$0	$0	$0	$0	$0	$0
CR	Vintage Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0
CR	Rack[a]	Medium	$0	$0	$0	$0	$0	$0	$0
CR	Rack[a]	Large	$0	$0	$0	$0	$0	$0	$0
CR	Marine Transport[a]	Small	-$373,600	$457,700	$84,100	$217,600	-$156,000	$149,100	-$224,500
CR	Marine Transport[a]	Medium	-$1,931,300	$2,178,900	$247,600	$1,041,800	-$889,500	$714,700	-$1,216,600
CR	Marine Transport[a]	Large	-$72,900	$21,700	-$51,200	$10,200	-$62,700	$7,000	-$65,900
CR	Cold Storage	Large	$0	$0	$0	$0	$0	$0	$0
IPR	IPR	Medium	-$59,800	$26,800	-$33,000	$12,800	-$47,000	$8,800	-$51,000
IPR	IPR	Large	-$1,655,700	$137,200	-$1,518,500	$65,100	-$1,590,600	$44,500	-$1,611,200
Leak Inspection			**$0**	**$39,939,300**	**$39,939,300**	**$39,939,300**	**$39,939,300**	**$39,939,300**	**$39,939,300**
CC	School & Tour Bus AC	Sub-Small	$0	$10,102,300	$10,102,300	$10,102,300	$10,102,300	$10,102,300	$10,102,300

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate		2% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2050	**2050**	**2050**	**2050**	**2050**	**2050**	**2050**
	Transit Bus AC	Sub-Small	$0	$3,579,100	$3,579,100	$3,579,100	$3,579,100	$3,579,100	$3,579,100
	Train AC	Sub-Small	$0	$534,200	$534,200	$534,200	$534,200	$534,200	$534,200
	Chiller	Medium	$0	$6,161,900	$6,161,900	$6,161,900	$6,161,900	$6,161,900	$6,161,900
	Chiller	Large	$0	$162,500	$162,500	$162,500	$162,500	$162,500	$162,500
CR	Modern Rail Transport[a]	Sub-Small	$0	$854,100	$854,100	$854,100	$854,100	$854,100	$854,100
	Condensing Unit	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Vintage Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Rack[a]	Medium	$0	$0	$0	$0	$0	$0	$0
	Rack[a]	Large	$0	$0	$0	$0	$0	$0	$0
	Marine Transport[a]	Small	$0	$2,971,800	$2,971,800	$2,971,800	$2,971,800	$2,971,800	$2,971,800
	Marine Transport[a]	Medium	$0	$15,054,600	$15,054,600	$15,054,600	$15,054,600	$15,054,600	$15,054,600
	Marine Transport[a]	Large	$0	$39,200	$39,200	$39,200	$39,200	$39,200	$39,200
	Cold Storage	Large	$0	$0	$0	$0	$0	$0	$0
IPR	IPR	Medium	$0	$281,900	$281,900	$281,900	$281,900	$281,900	$281,900
	IPR	Large	$0	$197,700	$197,700	$197,700	$197,700	$197,700	$197,700
Automatic Leak Detection			**$0**	**$5,713,900**	**$5,713,900**	**$5,713,900**	**$5,713,900**	**$5,713,900**	**$5,713,900**
CC	School & Tour AC	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Transit Bus AC	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Train AC	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Chiller	Medium	$0	$0	$0	$0	$0	$0	$0
	Chiller	Large	$0	$0	$0	$0	$0	$0	$0
CR	Modern Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate		2% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2050	2050	2050	2050	2050	2050	2050
	Condensing Unit	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Vintage Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Rack[a]	Medium	$0	$0	$0	$0	$0	$0	$0
	Rack[a]	Large	$0	$0	$0	$0	$0	$0	$0
	Marine Transport[a]	Small	$0	$0	$0	$0	$0	$0	$0
	Marine Transport[a]	Medium	$0	$327,100	$327,100	$327,100	$327,100	$327,100	$327,100
	Marine Transport[a]	Large	$0	$335,900	$335,900	$335,900	$335,900	$335,900	$335,900
	Cold Storage	Large	$0	$0	$0	$0	$0	$0	$0
IPR	IPR	Medium	$0	$0	$0	$0	$0	$0	$0
	IPR	Large	$0	$5,050,900	$5,050,900	$5,050,900	$5,050,900	$5,050,900	$5,050,900
Reporting & Recordkeeping			**$0**	**$7,361,138**	**$7,361,138**	**$7,361,138**	**$7,361,138**	**$7,361,138**	**$7,361,138**
CC, CR, and IPR	CC and CR 15-50 lbs.[a]	15-50	$0	$4,097,624	$4,097,624	$4,097,624	$4,097,624	$4,097,624	$4,097,624
	CC, CR, and IPR ≥50 lbs.	50+	$0	$3,263,514	$3,263,514	$3,263,514	$3,263,514	$3,263,514	$3,263,514
Total			**-$7,068,700**	**$64,911,238**	**$57,842,538**	**$58,685,038**	**$51,616,338**	**$56,901,738**	**$49,833,038**

Totals may not sum due to independent rounding.

[a] The costs and savings for Modern Rail Transport, Vintage Rail Transport, Rack, and Marine Transport reflect the requirements to use reclaimed material starting in 2029.

Appendix D. Modeled servicing demand for equipment affected by reclamation provisions, by HFC gas

Projected reclaimed refrigerant demand, accounting for the leak repair provisions in the final rule, is shown by species and equipment type in the Table D-1 below. In 2029, when the mandatory use of reclaimed refrigerants for service takes effect, the required reclaimed refrigerants for service in the subsectors specified are estimated to be 1,417 MT HFC-32, 5,110 MT HFC-125, 3,381 MT HFC-134a, and 2,259 MT HFC-143a.[61]

Table D-1 : Service Demand of HFCs for Applicable Subsectors in 2029[a]

Sector	***Refrigerant-Containing Equipment Type***	***Service Demand (MT)***			
		HFC-32	***HFC-125***	***HFC-134a***	***HFC-143a***
Supermarket Systems		1,265	3,561	2,621	1,213
Refrigerated Transport	Road	82	730	191	402
	Vintage	0	0	10	0
	Modern Rail	0	2	5	2
	Intermodal Containers	0	3	298	3
	Marine	58	789	236	622
Automatic Commercial Ice Makers		11	25	22	16
Total		**1,417**	**5,110**	**3,381**	**2,259**

[a] Results by gas represent demand for HFCs both as neat gases and as constituent gases within specific blends. For example, a significant driver of demand for HFC-32, HFC-125, and HFC-134a in the above table is driven by estimated servicing demand for R-407A, a blend of these three gases.

From 2029 through 2050, the amount of reclaimed HFCs needed to service the applicable refrigerant-containing equipment types is expected to decrease, in both mass and CO_2e terms, as more refrigerant-containing equipment transitions to alternatives. Further, as refrigerant-containing equipment using higher-GWPs comes offline, the model assumes some of that can be recovered and reused, alleviating the

[61] These values represent the full demand and do not incorporate the rule's allowance that up to 15 percent of the amount may be from virgin material.

need for reclaimed material. Tables D-2 and D-3 show the projected demand for servicing the designated refrigerant-containing equipment types in metric tons and $MMTCO_2e$.

Table D-2 : Service Demand of HFCs for Applicable Subsectors, 2029-2050 (Metric Tons)

	HFC-32	HFC-125	HFC-134a	HFC-143a	Total
2029	1,417	5,110	3,381	2,259	12,168
2030	1,389	4,889	3,274	1,978	11,530
2031	1,348	4,685	3,147	1,747	10,927
2032	1,292	4,477	2,988	1,546	10,303
2033	1,223	4,292	2,808	1,402	9,725
2034	1,148	4,095	2,621	1,254	9,119
2035	1,077	3,915	2,440	1,117	8,548
2036	1,005	3,730	2,255	976	7,967
2037	919	3,524	2,072	897	7,411
2038	831	3,313	1,884	816	6,844
2039	742	3,097	1,693	733	6,266
2040	651	2,878	1,498	650	5,677
2041	558	2,653	1,300	565	5,076
2042	464	2,436	1,098	495	4,494
2043	404	2,300	964	439	4,106
2044	415	2,318	971	398	4,101
2045	425	2,349	978	372	4,124
2046	436	2,380	985	346	4,147
2047	446	2,411	992	319	4,168
2048	457	2,442	999	291	4,189
2049	468	2,472	1,006	263	4,209
2050	472	2,495	1,014	266	4,247

Table D-3 : Service Demand of HFCs for Applicable Subsectors, 2029-2050 ($MMTCO_2e$)

	HFC-32	HFC-125	HFC-134a	HFC-143a	Total
2029	1.0	17.9	4.8	10.1	33.8
2030	0.9	17.1	4.7	8.8	31.6
2031	0.9	16.4	4.5	7.8	29.6
2032	0.9	15.7	4.3	6.9	27.7
2033	0.8	15.0	4.0	6.3	26.1
2034	0.8	14.3	3.7	5.6	24.5
2035	0.7	13.7	3.5	5.0	22.9
2036	0.7	13.1	3.2	4.4	21.3
2037	0.6	12.3	3.0	4.0	19.9
2038	0.6	11.6	2.7	3.6	18.5
2039	0.5	10.8	2.4	3.3	17.0
2040	0.4	10.1	2.1	2.9	15.6
2041	0.4	9.3	1.9	2.5	14.0
2042	0.3	8.5	1.6	2.2	12.6
2043	0.3	8.0	1.4	2.0	11.7
2044	0.3	8.1	1.4	1.8	11.6
2045	0.3	8.2	1.4	1.7	11.6
2046	0.3	8.3	1.4	1.5	11.6
2047	0.3	8.4	1.4	1.4	11.6
2048	0.3	8.5	1.4	1.3	11.6
2049	0.3	8.7	1.4	1.2	11.6
2050	0.3	8.7	1.5	1.2	11.7

Appendix E. Detailed Description of Mitigation Actions Modeled Specific to the ER&R Rule

For the MACC analysis used as the primary methodological tool, updated abatement options were calculated for leak repair, ALD, use of reclaimed refrigerant, and fire suppression-related provisions contained in the final rule for each year of the analysis period (2026–2050). For calculating break-even costs, abatement potential was calculated on a consumption basis (i.e., cost per ton of carbon dioxide equivalent consumption abated), to be comparable to the abatement options presented in the Allocation Rules and 2023 Technology Transitions Rules analyses.

Leak repair of appliances

Abatement options for leak repair were calculated for the equipment types and sizes analyzed in this RIA Addendum, using the same approach for estimating costs and benefits. In these options, because equipment owners would eventually add refrigerant to maintain that equipment in working order, it was assumed that emission benefits are equivalent to consumption benefits (i.e., that all avoided refrigerant emissions associated with repairing leaks translate into avoided consumption).

Table E-1 : Leak Repair abatement options added to MACC model for the subsection (h) Rule analysis in 2026

Abatement Option No.	Type	Equipment Type	Equipment Size	Breakeven Cost ($/mtCO$_2$e)
1	Leak repair	School & Tour Bus AC	Sub-small	$2,798.13
2	Leak repair	Transit Bus AC	Sub-small	$1,651.70
3	Leak repair	Passenger Train AC	Sub-small	$431.23
4	Leak repair	Chiller	Medium	$14.69
5	Leak repair		Large	$0.81
6	Leak repair	Modern Rail Transport	Sub-small	$534.15
7	Leak repair	Vintage Rail Transport	Sub-small	$349.47
8	Leak repair	Condensing Unit	Sub-small	$322.98
9	Leak repair	Marine Transport	Small	$21.46
10	Leak repair		Medium	$21.41
11	Leak repair		Large	$10.41
12	Leak repair	Rack	Medium	$21.56
13	Leak repair		Large	$9.24
14	Leak repair	Cold Storage	Large	-$0.22
15	Leak repair	IPR	Medium	$21.03
16	Leak repair		Large	-$0.62

Automatic leak detection systems

Abatement options for requiring ALD systems in existing and new systems were calculated for the equipment types and sizes shown in table A-4. The approach for estimating capital, installation, and O&M costs of ALD systems was based on the assumptions detailed in section 3.3 of this RIA Addendum.

The leak repair and inspection costs, refrigerant savings, and benefits of the ALD options were associated with repairs being conducted four weeks earlier (i.e., the incremental difference between the assumed six weeks earlier that repairs will be conducted without ALD and the 10 weeks earlier assumed for systems using ALD monitoring, as detailed in the draft RIA Addendum) and/or systems requiring fewer leak inspections (e.g., CR and IPR systems containing more than 1,500 pounds of refrigerant will switch from quarterly to annual inspections).

As with the added leak repair abatement options, it was assumed that emission benefits are equivalent to consumption benefits (i.e., that all avoided refrigerant emissions associated with repairing leaks translate into avoided consumption).

Table E-2: ALD abatement options added to MACC model for the subsection (h) Rule analysis in 2026

Option No.	Type	Equipment Type	Equipment Size	Breakeven Cost ($/mt$CO_2$e)
17	ALD	Marine Transport	Medium	-$2.13
18	ALD		Large	-$4.89
19	ALD	Rack	Medium	-$22.01
20	ALD		Large	-$15.78
21	ALD	Cold Storage	Large	-$2.09
22	ALD	IPR	Large	-$4.47

Use of reclaimed HFCs for servicing of equipment starting January 1, 2029

To quantify costs and benefits, a baseline for the use of reclamation in business-as-usual was first established. This baseline was derived from HFC reclamation totals modeled in the Vintaging Model[62] relative to modeled consumption for the RACHP and fire suppression sectors (i.e., new chemical demand

[62] The Vintaging Model assumes disposal recovery from equipment reaching end-of-life in a particular year is used to meet consumption demand for the same subsector and substance (i.e., new chemical demand plus servicing demand) in the same year (i.e., reclamation). If disposal recovery is not sufficient to meet consumption demand, the remainder is assumed to be produced as virgin manufacture.

and servicing demand) across the analysis period (2026-2050). The assumed percentage of demand met by reclaimed refrigerant in the baseline is 26.5 percent per year.

The costs and/or cost savings estimated for this activity included the refrigerant price difference in reclaimed refrigerant vs. virgin refrigerant. For the purposes of this analysis, it was assumed that the price of reclaimed refrigerant is 10 percent higher than virgin manufacture.[63] We provide a sensitivity analysis of this assumption in Appendix L.

The consumption benefits of this regulatory action needed to account for the proportion of virgin manufacture that the use of reclaimed refrigerant can offset. As discussed above, in our base case we assume there is already an increased recovery activity in the market, consistent with the compliance paths assumed in the Allocation Rules and the 2023 Technology Transitions Rule. In addition to accounting for those effects, we assume an additional offset stems from the final rule, which allows up to 15 percent virgin HFC material in reclaimed refrigerant.

This requirement was modeled as a series of abatement options that account for whether the equipment types for which reclaimed refrigerant must be used are covered or not covered by the leak repair requirements. For those equipment types covered by the leak repair requirements, the abatement options further distinguish between: a) leak repair above the leak threshold; and b) additional servicing and/or repair that would be conducted that is below the leak rate threshold.

- *Leak repair above the leak threshold, using reclaimed refrigerant, for marine transport, modern rail transport, vintage rail transport, and supermarket rack systems.*
    - To avoid double counting, these options supplant their equivalent, non-reclaim options listed above in Leak Repair and ALD (i.e., option numbers 6-7, 9-13, and 17-20), starting in 2029, when the requirement to use reclaim in servicing for the affected subsectors take effect. Costs and consumption benefits of leak repair using reclaimed refrigerant are calculated using the leak repair methods described in this RIA Addendum—but substituting the price of reclaimed refrigerant and applying the offsets for reclaim described above. EPA conservatively assumed that these measures would not result in an additional reduction in emissions beyond the emissions reductions from recovery of HFCs and avoided venting at disposal and servicing already included in the baseline.

[63] This baseline amount of reclaim is not accounted for in the costs/benefits of the leak repair options above (e.g., the average refrigerant price is assumed to represent the cost of virgin refrigerant).

Table E-3: Combined leak repair, ALD, and reclaim abatement options added to MACC model for the subsection (h) Rule analysis in 2029

Option No.	Type	Equipment Type	Equipment Size	Breakeven Cost ($/mtCO$_2$e)
23	Leak repair – reclaim	Modern Rail Transport	Sub-small	$912.53
24	Leak repair – reclaim	Vintage Rail Transport	Sub-small	$596.35
25	Leak repair – reclaim	Marine Transport	Small	$38.02
26	Leak repair – reclaim		Medium	$37.94
27	Leak repair – reclaim		Large	$18.06
28	Leak repair – reclaim	Rack	Medium	$38.43
29	Leak repair – reclaim		Large	$16.15
30	ALD – reclaim	Marine Transport	Medium	$36.72
31	ALD – reclaim		Large	$24.71
32	ALD – reclaim	Rack	Medium	$29.67
33	ALD – reclaim		Large	$17.59

- *Servicing and/or repair below the leak threshold using reclaimed refrigerant, for marine transport, modern rail transport, vintage rail transport, and supermarket rack systems.*
  - For these abatement options, the amount of servicing was based on the difference between the amount of refrigerant replaced in each year (2029–2050) in equipment leaking above the leak threshold and the baseline amount of servicing demand modeled for these equipment types in the Vintaging Model. As for other reclaim options, the assumed costs reflect the price of reclaimed refrigerant, and the consumption benefits apply offset factors for the continued use of virgin material (i.e., up to 15%) and the baseline percentage of demand met by reclaim (i.e., 26.5%). There are no emission benefits associated with these options.

Table E-4: Servicing reclaim abatement options added to MACC model for the subsection (h) Rule analysis in 2029

Option No.	Type	Equipment Type	Equipment Size	Breakeven Cost ($/mtCO₂e)
34	Servicing – reclaim	Modern Rail Transport	Sub-small	$0.33
35	Servicing – reclaim	Vintage Rail Transport	Sub-small	$0.62
36	Servicing – reclaim	Marine Transport	Small	$0.27
37	Servicing – reclaim		Medium	$0.27
38	Servicing – reclaim		Large	$0.34
39	Servicing – reclaim	Rack	Medium	$0.34
40	Servicing – reclaim		Large	$0.34

- *All servicing and/or repair for equipment types covered by the reclaimed refrigerant requirement but not covered by the leak repair requirement.*
    - For these abatement options, servicing demand was derived from EPA's Vintaging Model. As with other reclaim options, the assumed costs reflect the price of reclaimed refrigerant and the consumption benefits apply offset factors for the continued use of virgin material (i.e., up to 15%) and the baseline percentage of demand met by reclaim (i.e., 26.5%). There are no emission benefits associated with these options.

Table E-5: Additional servicing reclaim abatement options added to MACC model for the subsection (h) Rule analysis in 2029

Option No.	Type	Equipment Type	Breakeven Cost ($/mtCO₂e)
41	Servicing other equipment types – reclaim	Road Transport	$0.30
42	Servicing other equipment types – reclaim	Intermodal Containers	$0.60
43	Servicing other equipment types – reclaim	Automatic Commercial Ice Makers	$0.38

Fire suppression equipment

An additional set of abatement options was run for rule provisions associated with restricting intentional releases (e.g., during installation, servicing, repairing, or disposal) of fire suppression equipment. Abatement options for total flooding fire suppression systems were calculated assuming a proportion of the annual leakage amount (assumed to be 0.5 percent) for total flooding systems estimated in the Vintaging Model is avoided through the venting restriction. Cost savings are assumed because losses during testing of new or existing systems would have been replaced before the unit enters or reenters service.[64]

Additionally, fire suppression equipment is required to use recycled fire suppression agent for both servicing existing equipment (beginning in 2026) and to install new equipment (beginning in 2030). Because the venting restriction and recycled agent requirement for servicing/repair of fire suppression equipment start in the same year (2026), the venting prohibition option assumes that intentional venting during testing would have been replaced with recycled agent, and therefore, as for other reclaim options in the RACHP sector, the assumed costs reflect the price of recycled agent and the benefits apply the offset factors for the continued use of virgin material (i.e., up to 15%) and the baseline percentage of demand met by reclaim (i.e., 26.5%).

In addition, options associated with the requirement to use recycled agent in servicing (i.e., for normal operating leaks and servicing) for total flooding systems and filling of new fire suppression equipment for total flooding and streaming were considered. Costs and benefits for these options were calculated using the same approach as that used for refrigeration and AC equipment. The venting prohibition option is estimated to have emission benefits analogous to 0.5 percent of leak emissions for total flooding fire suppression systems. There are no associated emission benefits for the use of recycled agent for servicing and initial installation in fire suppression equipment.

Table E-6: Fire suppression abatement options added to MACC model for the subsection (h) Rule analysis in 2026 or 2030

Option No.	Type	Equipment Type	Breakeven Cost ($/mtCO$_2$e)

[64] An abatement option for the venting prohibition requirement is only applied to total flooding systems because streaming systems are not assumed to be serviced and therefore have no consumption benefits associated with avoiding leaks (i.e., losses from intentional venting are not replaced over the lifetime of the equipment). The potential emission benefits for streaming systems due to the venting prohibition are not calculated in this RIA addendum. Similarly, an abatement option for the servicing reclaim requirement is only applied to total flooding systems because streaming systems are not assumed to be serviced.

44	Venting prohibition – recycled	Fire Extinguishing: Flooding Agents	$0.26
45	Servicing– recycled	Fire Extinguishing: Flooding Agents	$0.26
46	Initial installation – recycled	Fire Extinguishing: Streaming Agents	$0.09
47	Initial installation – recycled	Fire Extinguishing: Flooding Agents	$0.26

Appendix F. Analysis of Alternative Reference Case

As discussed in section 3.1 of this document, the incremental costs and benefits of the final ER&R rule depend in part on the degree to which industry would have otherwise undertaken measures such as improved leak repair and recovery even in the absence of this regulation. Prior analyses conducted by EPA have illustrated multiple potential compliance pathways in response to existing AIM Act regulations, some of which included measures that would partially fulfill the requirements of the ER&R rule. These include actions taken in the fire protection subsector, improved leak repair, and additional recovery at disposal.

As discussed in the 2023 Technology Transitions Rule RIA Addendum, these measures are not required to meet compliance with prior AIM Act regulations, and the degree to which industry would undertake them in the absence of explicit requirements is uncertain. Since these fire protection, leak repair, and enhanced recovery measures were not found to be required to meet compliance with the Allocation and 2023 Technology Transitions Rules, they are not included in the primary reference case for this analysis. However, as a bounding exercise, this appendix provides the resulting incremental benefits of the final ER&R rule with an alternative reference case in which these measures are included. In other words, these measures are assumed to occur even in the absence of the ER&R Rule, thus illustrating a lower bound of the incremental climate benefits of the rule.

Table F-1 below provides a summary of the specific measures previously assumed as compliance options for the Allocation and 2023 Technology Transitions Rules RIA and RIA Addenda which are included in the reference case in the alternative scenario provided in this appendix. Transitions to lower-GWP options as assumed in the 2023 Technology Transitions Rule RIA remain as part of the reference case under this alternative scenario as they do in the primary reference case.

Table F-1– Reference Case Assumptions in ER&R Rule Base Case vs. Alternative Reference Case Scenario

Abatement Measure	*ER&R Alternative Reference Case Assumption*	*ER&R Base Case Assumption*
Leak Repair	Average leak rate for large RefAC equipment improves (i.e., is reduced) by 40% assumed in reference case. ER&R rule reclaim requirements only result in incremental emission reductions insofar as they require additional or earlier leak repairs beyond these levels.	No improvement in average leak rate for large RefAC equipment included in reference case beyond Vintaging Model BAU assumptions.
Disposal Recovery and Emissions	Improvement in end-of-life emissions rate to 3-4% of remaining equipment charge for large and small RACHP equipment assumed in reference case. ER&R rule reclaim requirements do not result in incremental emissions reductions and recovery rates beyond these levels.	No improvement in end-of-life emissions rate assumed in reference case beyond Vintaging Model BAU assumptions.
Fire Suppression	Fire suppression sector makes transitions away from HFCs to low-GWP alternatives in reference case. ER&R measures therefore affect smaller universe of fire suppression equipment.	Fire suppression sector does not make transitions away from HFCs to low-GWP alternatives in reference case. ER&R measures affect larger universe of fire suppression equipment still using HFCs.
RACHP, Foams, and Aerosol Transitions	All transitions in the 2023 Technology Transitions RIA Addendum Base Case are assumed in the reference case.	All transitions in the 2023 Technology Transitions RIA Addendum Base Case are assumed in the reference case.

Table F-2 and Table F-3 below provide the total MAC costs and emissions reductions in the ER&R Alternative Reference Case and Base Case Scenarios.

Table F-2- Incremental Annual Compliance Costs of MAC Abatement Measures under ER&R Alternative Reference Case and Base Case Scenarios (Millions 2022$)

	ER&R Alternative Reference Case Scenario			***ER&R Base Case***		
Year	Leak Repair	Reclamation	Fire Suppression	Leak Repair	Reclamation	Fire Suppression
2026	$69.5	$-	$0.1	$79.5	$-	$0.2
2030	$91.5	$2.2	$0.3	$88.3	$3.9	$0.8
2035	$78.8	$1.4	$0.2	$75.0	$3.1	$0.9
2040	$61.8	$1.6	$0.3	$57.5	$2.3	$0.9
2045	$45.2	$1.6	$0.4	$43.4	$1.8	$1.0
2050	$44.6	$2.1	$0.6	$43.3	$1.9	$1.0
PV (3% d.r.)	$1,183	$23	$5	$1,146	$38	$13

Table F-3- Incremental Annual Emissions Reductions from MAC Abatement Measures under ER&R Alternative Reference Case and Base Case Scenarios (MMTCO₂e)

	ER&R Alternative Reference Case Scenario			***ER&R Base Case***		
Year	Leak Repair	Reclamation	Fire Suppression	Leak Repair	Reclamation	Fire Suppression
2026	3.09	-*	0.01	5.39	-*	0.01
2030	3.41	-	0.01	5.63	-	0.01
2035	2.97	-	0.00	4.62	-	0.01
2040	2.16	-	0.00	3.01	-	0.01
2045	1.23	-	0.00	1.53	-	0.01
2050	0.83	-	0.00	0.92	-	0.01
Total	58.05	-	0.12	88.49	-	0.21

*Reclaim requirements may lead to additional emissions reductions by inducing increased recovery of refrigerant at servicing and disposal that may otherwise be released or vented. As described elsewhere in this RIA Addendum, EPA has conservatively assumed that these measures do not yield incremental HFC emissions reductions beyond model BAU levels.

Overall, these results indicate that there would be approximately 34% less reductions in emissions under the alternative reference case assumptions, while the present value of total costs would be approximately 1% higher than those of the ER&R base case.

For abatement measures corresponding to leak repair and ALD provisions, overall avoided emissions reductions decrease under the alternative reference case scenario, since average reference case equipment leak rates are lower (thus yielding lower “available” emissions reductions from repairs). However, because in most cases the overall scope of equipment with leak rates above the ER&R rule leak rate threshold remains the same under either scenario, costs remain similar, albeit with small changes due to cases where additional equipment exceed the leak rate threshold or where the measure results in additional refrigerant savings attributable to the rule as a result of the alternative assumptions.

For abatement measures corresponding to Fire Suppression, the inclusion of transitions away from HFCs for the broader sector in the alternative the reference case results in a smaller universe of equipment affected by the rule’s venting and use of recycled HFCs provisions. As a result, both emissions reductions and costs decrease under the alternative reference case scenario, relative to the base case.

Table F-4 below provides the benefits, costs, and net benefits under the alternative reference case scenario.

Table F-4 Summary of Annual Values, Present Values, and Equivalent Annualized Values select years for the 2026–2050 Timeframe for Estimated Compliance Costs, Benefits, and Net Benefits for this Rule (millions of 2022$, discounted to 2024) – Alternative Reference Case Scenario [a,b,c,d,e]

Year	Climate Benefits (3%)	Costs (2%, 3%, 7%)			Net Benefits (2% Benefits; 2%, 3% or 7% Costs)		
2026	$246	$82			$164		
2030	$481	$103			$379		
2035	$448	$88			$360		
2040	$370	$70			$300		
2045	$278	$52			$226		
2050	$249	$53			$196		
Discount rate	**3%**	**2%**	**3%**	**7%**	**2%**	**3%**	**7%**
PV	$6,205	$1,507	$1,342	$886	$4,697	$4,863	$5,319
EAV	$356	$77	$77	$76	$279	$279	$280

[a] Benefits include only those related to climate. Climate benefits are based on changes (reductions) in HFC emissions and are calculated using four different estimates of the social cost of HFCs (SC-HFCs): model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate. For the presentational purposes of this table, we show the benefits associated with the average SC-HFC at a 3 percent discount rate. See Chapter 5 for more discussion of the SC-HFC methodology.
[b] Rows may not appear to add correctly due to rounding.
[c] Present values are calculated using end of year discounting.
[d] The annualized present value of costs and benefits are calculated as if they occur over a 25-year period.
[e] The PV for the net benefits column is found by taking the difference between the PV of climate benefits at 3 percent and the PV of costs discounted at 7 percent, 3 percent or 2 percent. Because the SC-HFC estimates reflect net climate change damages in terms of reduced consumption (or monetary consumption equivalents), the use of the social rate of return on capital (7 percent under OMB Circular A-4 (2003)) to discount damages estimated in terms of reduced consumption would inappropriately underestimate the impacts of climate change for the purposes of estimating the SC-HFC. See Chapter 5 for more discussion.

Appendix G. SBREFA Assumptions and Methodology

This screening analysis finds that the rulemaking can be presumed not to have a ***significant economic impact on a substantial number of small entities (SISNOSE)***.

This section describes the approach and assumptions used to estimate the economic impact on small entities (businesses and governments) associated with the regulatory requirements for leak repair and use of automatic leak detection (ALD) systems for certain equipment using refrigerants containing HFCs with a GWP greater than 53 and certain substitutes; use of reclaimed HFCs in certain sectors or subsectors; the servicing, repair, disposal, or installation of fire suppression equipment that contains HFCs, as well as requirements related to technician training in the fire suppression sector; recovery of HFCs from cylinders; and reporting and recordkeeping; the decision matrix used to make the SISNOSE determination; and the aggregated small entities impacts.[65] The rulemaking applies to equipment used across a wide variety of businesses and government entities,[66] including school districts and cities. This analysis first assesses the economic impact to small businesses and small governments separately and then aggregates the impact across both types of entities to make a SISNOSE determination for the rulemaking.

Approach for Estimating the Economic Impact on Small Businesses

The analysis uses a model entity approach to estimate impacts on small businesses for the requirements for leak repair and use ALD; use of reclaimed HFCs in certain sectors or subsectors; the servicing, repair, disposal, or installation of fire suppression equipment that contains HFCs, requirements related to technician training in the fire suppression sector; and recovery of HFCs from cylinders. To estimate costs per small business, assumptions were developed for each industry category affected by the regulatory changes (i.e., the proportion of facilities that have appliances with refrigerant charges of 15 or more pounds) and the type and number of appliances per affected facility and business. Costs per model facility were developed to accurately reflect the range of compliance costs that a given small business owner or operator could experience from leak repair, leak inspection, ALD installation, and reporting and recordkeeping costs. Costs per model facility were then scaled to a model business on both an industry-specific and equipment-specific basis. Therefore, each model business reflects information about the average number of facilities a business has in a given industry category and equipment type (i.e., smaller businesses typically have fewer facilities per business than larger businesses).

The regulation also includes a requirement to recover refrigerant heels from disposable cylinders prior to disposal. Companies that sell and distribute HFCs, in particular refrigerant, will be impacted.

Model Facility and Small Business Cost Assumptions for Leak Repair and ALD Provisions

The model business approach is built up from the model equipment analysis described in Chapter 3 and model facility assumptions developed for the average number of refrigeration and air conditioning appliances and transit buses[67] per facility or business, for each industry category, as summarized in Table G-1 These assumptions were based on analysis of 2013 data reported under California's RMP, cross-

[65] Costs associated with certain several mobile end-uses (i.e., Modern Rail Transport, Passenger Train AC, Vintage Rail Transport, and Marine Transport) were not considered in this analysis, as it was determined that these equipment types are wholly owned and operated by large entities.
[66] The Regulatory Flexibility Act (RFA) defines small governments as the government of a city, county, town, township, village, school district, or special district with a population less than 50,000 (EPA 2022b).
[67] Approximately 10% of transit buses are assumed to be operated by private industry (e.g., charter buses) (APTA 2022).

walked with assumptions made by similar analyses (CARB 2009a; Stratus 2009) about equipment use by industry and reconciled with expert judgment.[68]

Table G-1 Average Number of Systems per Facility in Industries Containing Appliances with 15 or More Pounds of HFC Refrigerant

Industry Category	Average Systems per Facility		
	CC	CR	IPR
Agriculture and Crop Support Services	1	2	-
Arts, Entertainment, and Recreation	1	-	
Beverage and Ice Manufacturing	1	-	1
Charter Bus Industry	1		
Durable Goods Wholesalers and Dealers	2	-	-
Educational Services	4	1	-
Food Manufacturing	1	2	-
General Merchandise Stores	1	2	
Grocery and Specialty Food Stores	1	2	-
Hospitals	2	-	-
Ice Rinks	1	-	2
Non-durable Goods Wholesalers and Dealers	1	2	-
Non-food Manufacturing	2	-	3
Office Buildings	3	-	-
Other Warehousing, Storage, and Transportation	4	-	-

[68] Within each industry category, it was assumed that small businesses with annual revenue less than $200,000 do not utilize equipment with more than 15 pounds of refrigerant, given that these equipment typically cool larger spaces and equipment costs be cost prohibitive for these businesses (e.g., a typical commercial unitary air conditioning system can cost between $20,000 to $25,000, which would represent up to 25% of total annual revenue for a business with 2 CC units and an annual revenue of $200,000). Similarly, it was assumed that small businesses with revenue less than $500,000 would not utilize equipment with more than 1,500 pounds of refrigerant (i.e., would not have systems that require installation of ALD systems). Thus, these businesses would not have installed equipment affected by leak repair and inspection and ALD provisions of the rulemaking, respectively.

Industry Category	Average Systems per Facility		
	CC	CR	IPR
Refrigerated Warehousing and Storage	1	2	-
Research and Development	2	-	-
Utilities	2	-	-
Warehouse Clubs and Supercenters	1	3	

Potential compliance costs for each model facility were developed to accurately reflect the range of compliance costs that a given small business owner or operator could experience from leak repair, leak inspection, ALD installation, and reporting and recordkeeping requirements. For each business, there are many potential configurations of equipment types, equipment sizes, and repair outcomes that determine compliance costs for stock above the leak rate threshold. Considering these multiple possibilities, "worst case" model facility assumptions were adopted for standard leak repair and extension leak repair outcomes. The "worst case" reflects the possibility that appliances with leak rates above the threshold leak rate are clustered in individual facilities, such that all of the eligible appliances in a single model facility might trigger inspection and repair. Within each facility, it is assumed that multiple units of the same appliance type are maintained in the same way (e.g., if a facility has two CR systems, both appliances are assumed to have similar leak rates), and thus experience the same leak repair outcomes.

Model facility scenarios were developed for each industry category based on how many different sizes of appliances the industry is assumed to use within each sector and the expected number of leak repair outcomes. Retrofit outcomes were determined to only occur to a maximum of one piece of equipment per model facility. Each scenario features a different combination of appliance sizes and leak repair outcomes, with likelihood of each leak repair outcome based on estimates in Appendix A.

Economic impacts to small businesses associated with ALD installation and maintenance were also developed using the model facility approach. Although the number of potential configurations of equipment are lower because CC equipment are exempt from ALD requirements and only CR and IPR equipment with charge sizes greater than 1,500 pounds are impacted, a larger number of facilities are impacted because ALD requirements apply to new and existing CR and IPR equipment installed on or after January 1, 2017 with charge sizes greater than 1,500 pounds.[69]

Expected compliance costs per model facility were estimated by multiplying the (a) unit cost assumptions described in Appendix A averaged across all equipment within a given size category for each sector plus the expected reporting and recordkeeping costs per facility, by the (b) model facility configurations for each industry sector. Costs to small businesses were then scaled based on the proportion of facilities-to-businesses for small businesses in each size category of each NAICS code in each industry category.

Some small businesses within each NAICS code and industry category, that operate appliances that are subject to the rule (i.e., CC, CR, and IPR equipment containing more than 15 pounds of refrigerant), are not expected to experience any compliance costs. This is because not all systems will leak above the threshold leak rates, and therefore do not require leak repair or inspection or the installation of ALD systems. However, these businesses may be subject to increased costs associated with the requirement to use reclaimed refrigerant for the servicing and/or repair of appliances, as discussed further below.

Small Business Cost Assumptions for Reclamation and Recycling Provisions

The final rulemaking institutes several requirements related to the reclamation and recycling of HFCs. A review of reporting under the AIM Act indicates that there are 37 EPA-certified reclaimers, of which 32 are small businesses. Under the final rule, HFC refrigerant sold as reclaimed can contain no more than 15 percent virgin HFC refrigerant, by weight. It is not known how much virgin refrigerant is currently used for blending with reclaimed refrigerant, and therefore it is assumed that reclaimers will experience negligible cost impacts associated with this requirement.

Reclaimers are subject to labeling and recordkeeping requirements. Costs for labeling and recordkeeping are based on the estimated burden time to prepare each reporting element and are discussed in further detail in the Information Collection Request associated with this rulemaking.

The rulemaking requires the use of reclaim refrigerant for the servicing and/or repair of refrigerant-containing appliances in certain subsectors and applications in the RACHP sector, including supermarket systems, refrigerated transport, and automatic commercial ice makers, and the use of recycled HFCs for the servicing and/or repair of fire suppression equipment, including both total flooding systems and streaming applications. Many of the businesses subject to the leak repair and ALD requirements of the rulemaking would also be impacted by the requirement to use reclaimed or recycled HFCs for

[69] For the purposes of this screening analysis, facilities experiencing leak repair and inspection costs are separate from facilities experiencing ALD costs.

servicing/repair of certain refrigeration appliances and fire suppression equipment. Additional industries using equipment not covered by the leak repair and ALD provisions (e.g., road transport, intermodal containers, automatic commercial ice machines, and fire suppression equipment) were also identified.

Small businesses are anticipated to experience costs associated with the requirement to use reclaim refrigerant for servicing/repair of supermarket systems, refrigerated transport, and automatic commercial ice makers and recycled agent for servicing/repair of fire suppression equipment.[70] Servicing demand for these appliances and systems estimated by EPA's Vintaging Model was distributed across businesses in proportion to their annual sales (Census Bureau 2020) and it was assumed that businesses would incur a 10 percent price increase per pound of reclaimed or recycled HFCs (i.e., $0.40 per pound based on an assumed cost of $4 per pound for virgin material).

Small Business Cost Assumptions for Fire Suppression Provisions

The final rulemaking also institutes several additional requirements for fire suppression equipment containing HFCs. Specifically, fire suppression equipment containing a regulated substance may not release into the environment, such as by intentional venting during testing and EPA is requiring that all entities that employ fire suppression technicians who maintain, service, repair, install, or dispose of fire suppression equipment containing HFCs must provide training. EPA does not anticipate economic impacts associated with the restriction on intentional releases. Costs associated with technician training are discussed in further detail in the Information Collection Request associated with this rulemaking.

Furthermore, EPA is requiring that for the fire suppression sector where HFCs are used, the initial installation of fire suppression equipment, including both total flooding systems and streaming applications, must be with recycled HFCs, starting on January 1, 2030. A review of HFC fire suppression manufacturers indicates that 8 are small businesses. Manufacturers are anticipated to experience costs associated with the requirement to use recycled agent for the initial installation of fire suppression equipment. Demand for charging new fire suppression equipment estimated by EPA's Vintaging Model was distributed across businesses in proportion to their annual sales (Census Bureau 2020) and it was assumed that businesses would incur a 10 percent price increase per pound of recycled HFCs (i.e., $0.40 per pound).

Owners and operators of fire suppression equipment containing HFCs (including an HFC blend) dispose of this equipment by recovering the HFCs themselves or by arranging for HFC recovery by a fire suppression equipment manufacturer, distributor, or a fire suppressant recycler. EPA anticipates

[70] EPA's Vintaging Model does not assume streaming systems are serviced.

negligible to beneficial economic impacts associated with the requirement to recover HFCs from fire suppression equipment prior to disposal due to already established industry-wide practice to recover fire suppression agent and the resale value of recovered HFCs.

Small Business Cost Assumptions for Requiring Heel Recovery from Disposable Cylinders

The regulation also institutes a requirement to recover refrigerant heels from disposable cylinders (i.e., non-refillable cylinders), which are primarily used to charge and service stationary refrigeration and air-conditioning systems and fire suppression equipment. Disposable cylinders are specifically manufactured to be single use. These cylinders are charged with refrigerant, sold for use to fill or service equipment, and disposed (EIA 2018). Disposable cylinders are typically discarded with amounts of refrigerants still in the cylinders that will be emitted over time including from amounts commonly referred to as heels.

EPA is requiring that disposable cylinders that have been used for the servicing, repair, or installation of refrigerant-containing equipment or fire suppression equipment must be sent to a reclaimer, fire suppressant recycler, or a final processor for recovery of the heel. EPA is requiring that the recovered heel must be sent to a reclaimer for further processing.

Small Entities Potentially Subject to Refrigerant Heel Recovery Requirements

The requirement to remove heels from cylinders before disposal would directly impact those companies that sell or distribute or repackage refrigerant in such cylinders, as these companies would be required to return their used cylinder to a reclaimer or a final processor for heel recovery prior to disposal. For this analysis, potentially affected entities are assumed to be producers, importers, exporters, reclaimers, and companies that sell and distribute HFCs (e.g., blenders, repackagers, and wholesalers or distributors of refrigerants) and disposal facilities (i.e., landfills or recycling facilities).[71] Table G-2 lists the potentially affected industries by NAICS code and the estimated number of small businesses affected.

[71] For the purposes of this analysis, it is conservatively assumed that producers transport refrigerant primarily in containers larger than 30-lbs. cylinders and therefore the total inventory of 4.45 million disposable refrigerant cylinders, adjusted to account for the proportion of cylinders containing HFC or HFC blends with a GWP > 53, was distributed across importers, exporters, reclaimers, and companies that sell and distribute HFCs (e.g., blenders, repackagers, and wholesalers or distributors of refrigerants) defined by the NAICS codes in Table G-2.

Table G-2 - List of Industries Potentially Affected by the Prohibition of Disposable Cylinders by NAICS Code

NAICS Code	NAICS Industry Description	Size Standard in Millions of Dollars	Size Standard in Number of Employees	Estimated Number of Small Businesses Affected
325120	Industrial Gas Manufacturing		1,200	0[a]
562920	Materials Recovery Facilities	25		964[a]
423740	Refrigeration Equipment and Supplies Merchant Wholesalers		125	288[b]
423730	Warm Air Heating and Air-Conditioning Equipment and Supplies Merchant Wholesalers		175	1,017[b]
424690	Other Chemical and Allied Products Merchant Wholesalers		175	2,755[b]
562212	Solid Waste Landfill	47		609
238220	Plumbing, Heating, and Air-Conditioning Contractors	19		49,964

Source: Small Business Size Regulations, 3 CFR Part 121.201 (2023)

[a] Includes 32 known small business HFC reclaimers in addition to recycling facilities where disposable cylinders may be sent.

[b] It was assumed that 50 percent of businesses within these NAICS codes are refrigerant wholesalers and would be directly affected by the requirement to recover refrigerant heels from cylinders prior to disposal. It is also assumed that the remaining 50 percent of businesses could be affected by the prohibition of disposable cylinders such that they are considered within the universe of potentially affected entities but are expected to experience minimal economic impacts.

[c] It was assumed that 50 percent of businesses within this NAICS code are refrigerant contractors and would be directly affected by the requirement to provide a certification statement if technicians evacuate a cylinder prior to disposal. It is assumed that the remaining 50 percent of businesses are other types of contractors (i.e., plumbing) that are not impacted by the rulemaking.

Estimated Economic Impacts of Requiring Refrigerant Heel Removal from Cylinders prior to Disposal

For the purposes of quantifying direct compliance costs for this analysis, it was assumed that producers, importers, exporters, reclaimers, and companies that sell and distribute refrigerant currently sell refrigerant using 4.455 million disposable cylinders,[72] adjusted to the proportion of cylinders containing HFC and blends containing HFCs versus other non-regulated substances such as hydrofluoroolefins (HFOs) estimated by EPA's Vintaging Model (EPA 2023f),[73] as shown in Table G-3.

Table G-3 - Assumed Cylinder Refrigerant Mix, 2028-2050

Year	Percentage of Cylinders containing HFC and HFC blends
2028	76%
2029	75%
2030	73%
2031	72%
2032	71%
2033	70%
2034	69%
2035	69%
2036	68%
2037	67%
2038	67%
2039	66%

72 EPA estimates that there are 4.5 million refrigerant cylinders in circulation per year. Industry estimates that refillable cylinders account for between less than 1 percent and 10 percent of all 30-pound cylinders used, with a general assumption that the quantity of refillable cylinders as a percentage of all 30-pound cylinders used is closer to 1 percent (EPA 2024a). For the purposes of this analysis, it is assumed that 1 percent of all 30-pound cylinders sold in the United States are refillable (i.e., 45,000) and are therefore excluded from the heel recovery requirement.

73 As explained in the RIA to the Allocation Framework Rule and associated addenda to that RIA, the Vintaging Model estimates the consumption and emissions from end-uses that traditionally relied on ODS and are transitioning to HFCs and other alternatives. The EPA (2023f) version of the model (VM IO file_v4.4_02.04.16_Final TT Rule 2023.xls) incorporates the transitions and practices anticipated to occur under the 2023 Technology Transitions RIA Base Case, which in turn incorporates provisions of that rule.

Year	Percentage of Cylinders containing HFC and HFC blends
2040	66%
2041	66%
2042	65%
2043	65%
2044	65%
2045	65%
2046	65%
2047	65%
2048	64%
2049	64%
2050	64%

All direct compliance costs are calculated as the difference between costs and savings currently incurred under the current business-as-usual (BAU) scenario and those estimated to be incurred under the provisions of the rulemaking.

Cost of transport. In the BAU scenario, disposable cylinders are assumed to travel from gas producer/filler to the wholesale distributor; wholesale distributor to end user/technician; and end user/technician to a disposal facility (e.g., landfill or steel recycler).

Transportation costs were updated to account for the distance traveled for each trip and the use of company fleets to transport cylinders based on a CARB (2011) analysis. It is assumed that companies already own or lease the proper vehicle fleet to transport cylinders.

Table G-4 summarizes distances per shipment for disposable cylinders. Based on the location of chemical production facilities around the United States, located primarily along the East Coast, Midwest, Southern United States, and California, it is assumed that a cylinder would travel an average of 1,000 miles from producer to the wholesale distributor. As assumed in CARB (2011), the distance between wholesale distributor and end-user/technician is assumed to be 25 miles. Other distances—75 miles from an end-user or wholesaler to a disposal facility and 50 miles from a distributor to a reclaimer— were also based on CARB (2011).

In the recovery scenario, it was assumed that approximately one-third of non-refillable cylinders would take one of three potential transportation scenarios: 1) cylinders would be returned directly to a reclaimer for heel recovery; 2) cylinders would be returned to the distributor and then to a disposal facility for heel recovery; or 3) cylinders would be sent directly to a disposal facility for heel recovery. Upon recovery of the heel, the disposal facility would store recovered refrigerant heels until the facility has accumulated enough refrigerant to send to a reclaimer. Based on an average heel of 0.96 pounds, it is assumed that a disposal facility would recover refrigerant from 25 cylinders in order to accumulate enough to fill one 30-pound cylinder (i.e., 24 pounds of refrigerant).

Table G-4 - Travel Distances for Disposable Cylinders Before Disposal

Trip	BAU	Recovery Scenario				
		Disposable-1[a]	Disposable-2[a]		Disposable-3[a]	
		End-user to Reclaimer to Disposal Facility	End-user to Distributor to Disposal	Disposal Facility to Reclaimer	End-user to Disposal Facility	Disposal Facility to Reclaimer
Gas producer/filler to wholesale distributor	1,000	1,000	1,000	NA	1,000	NA
Wholesale distributor to end user/technician	25	25	25	NA	25	NA
End user/technician to disposal facility	75	NA	NA	NA	75	NA
End user/technician to reclaimer	NA	50	NA	NA	NA	NA
End user/technician to distributor	NA	NA	25	NA	NA	NA
Wholesale distributor or	NA	75	75	NA	NA	NA

reclaimer to disposal facility						
Disposal facility to Reclaimer	NA	NA	NA	75[b]	NA	75[b]
Total Miles	**1,100**	**1,150**	**1,125**	**75**	**1,110**	**75**

[a] Assumed for one-third of shipped HFC cylinders.

[b] Disposal facilities are assumed to recover refrigerant from 25 cylinders before sending one 30-lb cylinder (containing 24 pounds of refrigerant) to a reclaimer.

Table G-5 provides additional assumptions related to fuel use and labor associated with transporting cylinders.

Table G-5 - Additional Transportation Assumptions

Parameter	Assumption
Average Fuel Efficiency	6.1 miles per gallon[a]
Diesel Fuel Cost	$4.034/gallon[b]
Average Truck Speed	50 miles per hour[c]
Labor Rate (Truck Transport)	$53.59[d]

[a] Geotab (2017)

[b] U.S. EIA (2024)

[c] CARB (2011)

[d] Labor rate for Heavy and Tractor-Trailer Truck Drivers from Bureau of Labor Statistic's Employer Costs for Employee Compensation – May 2022. Median hourly wages rates were multiplied by a factor of 2.1 to reflect the estimated additional costs for overhead (BLS 2023b).

Transportation costs were then calculated on a per cylinder basis. This analysis conservatively estimates transportation costs on a per cylinder basis assuming a truck could fit approximately 1,120 disposable cylinders (CARB 2011). Table G-6 summarizes the transport cost per cylinder based on the assumptions presented above.

To calculate annual transport costs per small business, it was assumed that a total of 4.445 million disposable cylinders are transported per year (adjusted for the proportion HFC and HFC blends in use per year, according to Table G-3) under both the BAU scenario and the provisions of the rulemaking. The number of cylinders transported before disposal per small business was distributed across businesses in proportion to their annual sales (Census Bureau 2020).

Table G-6 - Transportation Assumptions before Disposal per Cylinder

Scenario		Fuel Costs	Labor	Total
BAU	Disposable	$0.65	$1.05	$1.70
Recovery Scenario	Disposable-1 [a]	$0.68	$1.10	$1.78
	Disposable-2[a]	$0.66	$1.08	$1.74
	Disposable-2 (Disposal Facility)[b]	$0.002	$0.003	$0.005
	Disposable-3[a] (End-user)	$0.65	$1.05	$1.70
	Disposable-3 (Disposal Facility)[b]	$0.002	$0.003	$0.005

[a] Assumed for one-third of HFC cylinders sold per year.

[b] Disposal facilities are assumed to recover refrigerant from 25 cylinders before sending one 30-lb cylinder (containing 24 pounds of refrigerant) to a reclaimer.

Recovered heel. Under the recovery scenario, disposable cylinders are returned to a reclaimer prior to disposal containing a refrigerant heel that is recovered and sold back into the market. It was assumed that cylinders contain a heel of approximately 0.96 pounds based on CARB (2011) and expert judgment. Recovered refrigerant is assumed to be resold at approximately $4 per pound based on average refrigerant costs applied in EPA (2021a). The total annual savings associated with recovered heel was distributed across businesses in proportion to their assumed number of cylinders (as estimated under previous steps).

Reporting and Recordkeeping. Under the recovery scenario, companies that sell or distribute or repackage refrigerant in disposable cylinders, final processors, and refrigerant reclaimers and fire suppressant recyclers are also subject to reporting and recordkeeping requirements. Specifically, if a certified technician evacuates a disposable cylinder prior to discarding the cylinder, they must provide a certification statement certifying that the cylinder was evacuated to a level of 15 in-Hg for each disposable cylinder handled and discarded to the final processor. The final processor must keep this record for a period of 3 years. In addition, reclaimers and refrigerant distributors who supply reclaimed HFCs are subject to a discrete reporting requirement in 2027 and 2028 on the volume of reclaimed HFCs intended for servicing and/or repair of appliances in use in certain subsectors.

These reporting and recordkeeping costs are based on the estimated burden time to prepare each reporting element and are discussed in further detail in the Information Collection Request associated with this rulemaking.

Table G-7 summarizes the cost assumptions associated with the requirement to recover the refrigerant heel from disposable cylinders prior to disposal. Because the proportion of disposable cylinders changes per year as equipment is assumed to transition towards lower-GWP substitutes that are not regulated by this rulemaking, the sales test was performed for 2028 for which the highest proportion of HFC cylinders are assumed in circulation, as shown in Table G-3 (i.e., 76 percent), and therefore the highest potential cost impacts.

Table G-7 - Cost Assumptions for BAU and Rulemaking from Cylinder Heel Recovery Requirement

Assumption		**BAU**	**Rulemaking**			
			Reclaimer	**Wholesaler or Distributor**	**Disposal Facility**	**Refrigerant Technician**
Number of Disposable Cylinders Disposed (2028)		3,370,585	1,123,528	2,247,057		337,059[a]
Average Transport Cost per Cylinder		$1.70	$1.78	$1.72[b]	$0.005[b]	NA
Cylinder Heel Amount (lbs.) and Percent of Cylinder		0.96 (4%)	0.96 (4%)	0.96 (4%)	0.96 (4%)	0.96 (4%)
Average Refrigerant Price ($/lbs.)		$4	$4	$4	NA	NA
Reporting and Recordkeeping	Certification of Evacuation to 15-in Hg (per cylinder)[a]	NA	NA	NA	NA	$28.93
	Recordkeeping of Certification Statement (per cylinder)[a]	NA	NA	NA	$1.79	NA
	Reclaim Use Volume Report[d]	NA	$646.46	$530.21	NA	NA
	Labeling and Recordkeeping[e]	NA	$4,391	NA	NA	NA

[a] Approximately 10 percent of cylinders are assumed to be emptied directly by the end-user (i.e., refrigerant technician) and require a certification statement.

Assumption	BAU	Rulemaking			
		Reclaimer	Wholesaler or Distributor	Disposal Facility	Refrigerant Technician

[b] Represents an average of the per-cylinder cost for wholesalers or distributors under disposable scenario 2 ($1.74 per cylinder) and disposable scenario 3 ($1.70 per cylinder) as shown in Table G-6.

[c] Disposal facilities are assumed to recover refrigerant from 25 cylinders before sending one 30-lb cylinder (containing 24 pounds of refrigerant) to a reclaimer.

[d] Two-time report submitted by reclaimers and refrigerant distributors in 2027 and 2028 only.

[e] Represents one-time label redesign and recordkeeping costs for reclaimers noted in Section "Small Business Cost Assumptions for Reclamation and Recycling Provisions."

Summary of Economic Impacts. To inform the sales test, economic data about each affected industry—including number of firms by employment and receipts size—was obtained from the U.S. Census Bureau's Statistics of U.S. Businesses. Annualized compliance costs for 2028 for small businesses in each affected industry were compared to annual sales by firm size, as shown in Table G-8. As shown, small businesses are expected to experience a positive economic impact (i.e., cost savings) or impact less than 1 percent of annual sales associated with the requirement to recover heels prior to cylinder disposal.

Table G-8 - Summary of Annual Economic Impacts from Cylinder Heel Recovery Requirement on Small Businesses by NAICS Code, 2028

Employee Size or Annual Revenue[a]	Number of Small Businesses Affected	Average Annual Sales per Firm	Assumed Cylinder Fleet per Firm or Cylinders Returned[b]	Annual Cost per Small Business			Total Annual Cost per Small Business	Impact as Percent of Annual Sales
				Average Incremental Annual Transport Costs	Heel Savings	Reporting & Recordkeeping		
Materials Recovery Facilities (Reclaimers)								
<5	13	$954,057	21	$1	-$81	$5,044	$4,964	0.52%
5-9	10	$2,727,975	60	$2	-$231	$5,044	$4,816	0.18%
10-19	6	$4,487,174	99	$4	-$380	$5,044	$4,668	0.10%
20-99	12	$11,410,450	251	$10	-$966	$5,044	$4,088	0.04%
100-499	1	$22,630,407	499	$19	-$1,915	$5,044	$3,148	0.01%
Refrigeration Equipment and Supplies Merchant Wholesalers								
<5	133	$835,730	18	$1	-$68	$621	$554	0.07%
5-9	63	$4,405,621	97	$4	-$359	$621	$266	0.006%
10-19	42	$7,287,619	161	$6	-$594	$621	$33	<-0.001%
20-99	42	$27,967,987	616	$24	-$2,280	$621	-$1,635	-0.006%
100-149	23	$52,375,136	1,154	$45	-$4,269	$621	-$3,603	-0.007%
Warm Air Heating and Air-Conditioning Equipment and Supplies Merchant Wholesalers								

Employee Size or Annual Revenue[a]	Number of Small Businesses Affected	Average Annual Sales per Firm	Assumed Cylinder Fleet per Firm or Cylinders Returned[b]	Annual Cost per Small Business			Total Annual Cost per Small Business	Impact as Percent of Annual Sales
				Average Incremental Annual Transport Costs	Heel Savings	Reporting & Recordkeeping		
<5	391	$1,435,428	32	$1	-$120	$621	$502	0.03%
5-9	206	$4,027,378	89	$3	-$337	$621	$288	0.007%
10-19	170	$8,824,460	194	$8	-$738	$621	-$109	-0.001%
20-99	214	$28,135,080	620	$24	-$2,352	$621	-$1,707	-0.01%
100-199	36	$74,021,716	1,631	$63	-$6,187	$621	-$5,503	-0.01%
Other Chemical and Allied Products Merchant Wholesalers								
<5	1,526	$2,142,742	47	$2	-$180	$621	$442	0.02%
5-9	504	$6,251,162	138	$5	-$526	$621	$99.93	0.0016%
10-19	345	$15,508,336	342	$13	-$1,306	$621	-$672	-0.004%
20-99	341	$35,522,558	783	$30	-$2,991	$621	-$2,340	-0.01%
100-149	39	$143,599,156	3,165	$122	-$12,091	$621	-$11,347	-0.01%
Materials Recovery Facilities (Recyclers)								
<5	380	$954,057	4	$0.02	-	$177	$177	0.02%

Employee Size or Annual Revenue[a]	Number of Small Businesses Affected	Average Annual Sales per Firm	Assumed Cylinder Fleet per Firm or Cylinders Returned[b]	Annual Cost per Small Business			Total Annual Cost per Small Business	Impact as Percent of Annual Sales
				Average Incremental Annual Transport Costs	Heel Savings	Reporting & Recordkeeping		
5-9	178	$2,727,975	10	$0.05	-	$505	$505	0.02%
10-19	151	$4,487,174	17	$0.08	-	$831	$831	0.02%
20-99	174	$11,410,450	43	$0.20	-	$2,114	$2,114	0.02%
100-499	49	$22,630,407	86	$0.40	-	$4,192	$4,193	0.02%
Solid Waste Landfill								
<$100	31	$67,016	1	$0.00	-	$12	$12	0.02%
$100-499	167	$342,772	1	$0.00	-	$63	$64	0.02%
$500-999	114	$898,137	3	$0.01	-	$166	$166	0.02%
$1,000-2,499	132	$1,998,150	8	$0.04	-	$370	$370	0.02%
$2,500-4,999	74	$4,132,387	16	$0.07	-	$766	$766	0.02%
$5,000-7,499	32	$6,717,014	26	$0.12	-	$1,244	$1,244	0.02%
$7,500-9,999	11	$9,181,946	35	$0.16	-	$1,701	$1,701	0.02%
$10,000-14,999	16	$13,290,027	51	$0.24	-	$2,462	$2,462	0.02%
$15,000-19,999	8	$18,042,643	69	$0.32	-	$3,342	$3,343	0.02%

Employee Size or Annual Revenue[a]	Number of Small Businesses Affected	Average Annual Sales per Firm	Assumed Cylinder Fleet per Firm or Cylinders Returned[b]	Annual Cost per Small Business			Total Annual Cost per Small Business	Impact as Percent of Annual Sales
				Average Incremental Annual Transport Costs	Heel Savings	Reporting & Recordkeeping		
$20,000-24,999	9	$18,842,779	72	$0.33	-	$3,491	$3,491	0.02%
$25,000-29,999	8	$23,202,340	88	$0.41	-	$4,298	$4,299	0.02%
$35,000-39,999	3	$37,499,500[c]	143	$0.66	-	$6,947	$6,947	0.02%
$40,000-49,999	4	$28,208,524	107	$0.50	-	$5,226	$5,226	0.02%
Refrigerant Technicians[d]								
<$100	10,648	$59,313	7	-	-	$203	$203	0.34%
$100-499	16,969	$284,372	7	-	-	$203	$203	0.07%
$500-999	8,208	$846,409	7	-	-	$203	$203	0.02%
$1,000-2,499	8,098	$1,836,287	7	-	-	$203	$203	0.01%
$2,500-4,999	3,327	$4,083,819	7	-	-	$203	$203	0.005%
$5,000-7,499	1,209	$7,105,073	7	-	-	$203	$203	0.003%
$7,500-9,999	576	$10,040,971	7	-	-	$203	$203	0.002%
$10,000-14,999	605	$14,071,905	7	-	-	$203	$203	0.001%
$15,000-19,999	326	$19,865,787	7	-	-	$203	$203	0.001%

Employee Size or Annual Revenue[a]	Number of Small Businesses Affected	Average Annual Sales per Firm	Assumed Cylinder Fleet per Firm or Cylinders Returned[b]	Annual Cost per Small Business			Total Annual Cost per Small Business	Impact as Percent of Annual Sales
				Average Incremental Annual Transport Costs	Heel Savings	Reporting & Recordkeeping		

[a] In thousands of dollars.

[b] Disposal facilities are assumed to recover refrigerant from 25 cylinders before sending one 30-lb cylinder (containing 24 pounds of refrigerant) to a reclaimer.

[c] Revenue data was not available for businesses in the $35,000-39,999 revenue category. For purposes of the sales test, revenue was estimated as the midpoint of the $35,000-39,999 revenue range (i.e., $37,499).

[d] Approximately 10 percent of cylinders are assumed to be emptied directly by the end-user (i.e., refrigerant technician) and require a certification statement. Cylinders were equally distributed across refrigerant technician businesses under the assumption that the size of the business would not be relevant in the decision-making for a technician to choose to empty a cylinder directly. Distributing cylinders equally is a more conservative assumption as it assumes a larger number of cylinders are handled by small businesses than if cylinders were distributed proportional to sales.

Approach for Estimating the Economic Impact on Small Governments

This analysis also uses a model entity approach to estimate impacts on small school districts and small governments for the leak repair, leak inspection, and recordkeeping and reporting requirements for school buses and transit buses, respectively.[74]

In the United States, there are approximately 13,085[75] school districts with a total enrollment of 33.1 million students as of 2018 (Urban Institute Education Data Portal 2022) and 482,714 yellow school buses[76] (EPA 2023). There are approximately 57,006 public transit buses in the United States serving over 174 million people in 3,030 cities as of 2017 (GFOA N.d.). This analysis assumes that each school district utilizes school buses for student transportation, and each city utilizes transit buses for public transportation. Furthermore, although approximately 40% of school buses and 28% of transit buses are contracted, it is assumed that costs associated with the rulemaking would be passed down to the individual school districts and cities (APTA 2022). Therefore, this analysis assumes that every school district and city is potentially impacted by the rulemaking.

Model Facility and Small Government Cost Assumptions

To analyze and estimate the economic impact of the leak repair and inspection provisions on school and transit buses, school districts were grouped into ten groups based on enrollment and transit buses were grouped into thirteen groups based on population. For school districts, the average enrollment, population within the school district, and revenue for the associated local government of each school district were determined for each enrollment size. For cities, the average population and revenue for the associated local government of each city were determined for each population size. Of the ten school enrollment groups, four were defined as small government with an average population of 50,000 or less and represent 12,187 school districts. Of the thirteen city population groups, four were defined as a small government with populations less than 50,000 and represent 2,276 cities.

As noted above, there are approximately 482,714 yellow school buses in use in the United States across 13,085 school districts. Approximately 51% of students ride a school bus as their primary means of transportation (USAFacts 2022), which equates to an average of 34 students per school bus. With

[74] Approximately 90% of transit buses are assumed to be operated by transit agencies (APTA 2022).
[75] 56 school districts have an enrollment of 0 students and were therefore not included in this analysis.
[76] While federal law does not require school buses to be yellow, the National Highway Traffic Safety Administration (NHTSA) provides recommendations to states on transportation safety and operational aspects of school buses. Along with other matters and uniform identifying characteristics, NHTSA recommends that school buses be painted "National School Bus Glossy Yellow".

approximately 51,305 public-owned transit buses, about 5% of the total population utilizes bus transit (Census Bureau 2021), which equates to an average of 180 people per bus.

Table G-9 summarizes the average enrollment, population, revenue, and number of school buses per school district within the four small government enrollment groups and the average population, revenue, and number of transit buses per city within the four small government population groups.

Table G-9 - School District and City Government Population and Revenue by Enrollment and Population Size

Enrollment Group	Number of Districts	Average Enrollment per District	Average Population per District	Average Revenue per District	Average School Buses per District
School Buses					
0-500	5,524	235	1,875	$4,138,069	3
501-999	2,538	712	5,458	$11,246,957	10
1,000-4,999	3,726	2,244	17,058	$37,866,965	33
5,000-9,999	399[a]	6,930	52,355	$112,226,575	101
	Population Group	**Number of Cities**	**Average Population per City**	**Average Revenue per City**	**Average Transit Buses per City**
Transit Buses					
	10,000-19,999	1,235	14,128	$29,805,843	4
	20,000-29,999	542	24,465	$51,459,646	7
	30,000-39,999	314	34,642	$72,953,140	10
	40,000-49,999	185	44,702	$99,530,151	13

Bolded rows represent a small government school district.

Source: Urban Institute Education Data Portal (2022) and Government Finance Officers Association (n.d.).

a Approximately 59% of the school districts within the 5,000-9,999 enrollment group are below the small government threshold.

Based on the analysis outlined in Appendix A, 68,158 school buses with charge sizes greater than 15 pounds and 24,147 transit buses are anticipated to exceed the threshold leak rate in 2028, and both are assumed to experience the leak repair outcomes outlined in Table G-10. Total standard leak repairs are distributed to every school district and city in proportion to the number of buses each school district and city uses. Because there are significantly fewer extension and retrofit repairs than standard leak repairs, extension and retrofit repairs are distributed within each group based on total number of buses within each group such that some districts and cities within each enrollment and population size will experience extension and/or retrofit repairs. This analysis therefore assumes that every school district and city experiences at least one standard leak repair, but not every school district and city is assumed to experience an extension or retrofit repair.

Table G-10 - Leak Repair Outcomes per School District or City

Enrollment Group	School Districts	Average School Buses per District	Total School Buses per Enrollment Group	Standard Repairs per School District	Extension Repair per Enrollment Group	Retrofit Repair per Enrollment Group
School Buses						
0-500	5,524	3	16,572	1	20	23
501-999	2,538	10	25,380	1	30	35
1,000-4,999	3,726	33	122,958	4	147	168
5,000-9,999	399	101	40,299	14	48	55
Population Group	**Cities**	**Average Transit Buses per City**	**Total Transit Buses per Population Group**	**Standard Repairs per City**	**Extension Repair per City**	**Retrofit Repair per City**
Transit Buses						
10,000-19,999	1,235	4	4,940	2	20	23
20,000-29,999	542	7	3,794	3	15	17
30,000-39,999	314	10	3,140	4	13	14
40,000-49,999	185	13	2,405	6	10	11

To estimate the economic impact of the leak repair and inspection provisions on school buses, four model government scenarios were established to represent various combinations of leak repair outcomes for each school district: standard repair only, standard repair + extension repair, standard repair + retrofit repair, and standard repair + extension repair + retrofit repair.

The four model governments are established based on the lowest number of repair type instances (in this case, extension repairs). It was therefore assumed that 50% of extension and retrofit repairs are experienced by a school district and city in addition to the assumed standard repair(s) for each group (i.e., standard repair + extension repair or standard repair + retrofit) and 50% of extension and retrofit repairs are experienced together by a school district and city in addition to the assumed standard repair(s) for each group (i.e., standard leak repair + extension repair + retrofit repair). The number of school districts and cities affected by each leak repair scenario is summarized in Table G-11.

Table G-11 - Number of School Districts and Cities Affected by Leak Repair Scenarios

Enrollment Group	School Districts	Average School Buses per District	Number of School Districts Impacted			
			Standard Repair Only	Standard + Extension Repair	Standard + Retrofit Repair	Standard + Extension + Retrofit Repair
School Buses						
0-500	5,524	3	5,491	10	13	10
501-999	2,538	10	2,488	15	20	15
1,000-4,999	3,726	33	3,485	74	95	74
5,000-9,999	399	101	320	24	31	24
Population Group	**Cities**	**Average Transit Buses per City**	**Number of Cities Impacted**			
			Standard Repair Only	**Standard + Extension Repair**	**Standard + Retrofit Repair**	**Standard + Extension + Retrofit Repair**
Transit Buses						
10,000-19,999	1,235	4	1,204	10	13	10
20,000-29,999	542	7	518	8	10	8
30,000-39,999	314	10	294	7	8	7
40,000-49,999	185	13	169	5	6	5

Cost estimates for each leak repair scenario were applied to each school district and city to evaluate the burden compared to their average revenue (see Appendix A for discussion of leak repair, leak inspection, and reporting and recordkeeping cost estimates).

Decision Matrix for Determining Significant Economic Impact on a Substantial Number of Small Entities

This analysis uses the matrix shown in Table G-12 to determine whether this rulemaking would impose a SISNOSE. The economic threshold levels are set conservatively at 1% and 3% of sales, consistent with similar analyses of other Clean Air Act Title VI rules. These thresholds are set conservatively because the rulemaking affects small businesses in a range of different industries, which may have significantly different profit margins and abilities to pass compliance costs along to customers, and a range of small governments with significantly different revenue. Based on this decision matrix, this screening analysis finds that the rulemaking can be presumed to have **no SISNOSE**.

Table G-12 - Decision Matrix for Certifying SISNOSE

Economic Impact	Number of Small Entities Subject to the Rule and Experiencing Given Economic Impact	Percent of All Small Entities Subject to the Rule That Are Experiencing Given Economic Impact	Certification Category
Less than 1% for all affected small entities	Any number	Any percent	Presumed No SISNOSE
1% or more for one or more affected small entities	Fewer than 100	Less than 20%	Presumed No SISNOSE
	Fewer than 100	20% or more	Uncertain – No Presumption
	Between 100 and 999	Less than 20%	Presumed No SISNOSE
	Between 100 and 999	20% or more	Uncertain – No Presumption
	1000 or more	Any percent	Uncertain – No Presumption
Greater than 3% for one or more affected small entities	Fewer than 100	Less than 20%	Presumed No SISNOSE
	Fewer than 100	20% or more	Uncertain – No Presumption
	Between 100 and 999	Less than 20%	Uncertain – No Presumption
	Between 100 and 999	20% or more	Presumed Ineligible for Certification
	1000 or more	Any percent	Presumed Ineligible for Certification

Aggregate Small Entities Impacts of Regulatory Changes

As shown in Table G-13, an estimated 753,105 small businesses and 14,463 small governments may be subject to the regulatory actions.

Table G-13 - Summary of the Small Entities Impact

Entity	Estimated Number of Small Entities Affected by the Rule
Small Business Industry Type	
Accommodations	8,522
Agriculture and Crop Support Services	3,015
Arts, Entertainment, and Recreation	183
Beverage and Ice Manufacturing	424
Charter Bus Industry	920
Disposal and Recycling Facilities	1,541
Durable Goods Wholesalers and Dealers	867

Entity	Estimated Number of Small Entities Affected by the Rule
Educational Services	175
Electronics Manufacturing	1,563
Fire Suppression Manufacturers	8
Fitness and Recreational Sports	387
Food manufacturing	3,788
Grocery and Specialty Food Stores	48,556
Hospitals	354
Materials Recovery Facilities (Reclaimers)	32
Non-durable Goods Wholesalers and Dealers	2,364
Non-food Manufacturing	43,271
Office Buildings	9,594
Other Chemical and Allied Products Merchant Wholesalers	2,755
Other Warehousing, Storage, and Transportation	50,882
Petrochemical Manufacturing	6
Refrigerant Technicians	49,964
Refrigerated Warehousing and Storage	399
Refrigeration Equipment and Supplies Merchant Wholesalers	280
Restaurants and Food Services	488,180
Support Activities for Transportation	218
Telecommunications and Information Services	29,695
Utilities	4,146
Warm Air Heating and Air-Conditioning Equipment and Supplies Merchant Wholesalers	1,017
Small Government Type	
School Districts	12,187
City Government	2,276
Total	**767,568**

Totals may not sum due to independent rounding.

To analyze the economic impacts on small entities against the SISNOSE decision matrix, a “sales test” was applied, which calculates annualized compliance costs as a percentage of annual sales for businesses in each NAICS code by size category and annual revenue for governments. Total economic impact includes incremental compliance costs for leak repair and inspection and ALD installation, as well as compliance costs for reporting and recordkeeping. For industries for which annual sales data were not available through the Economic Census, annual receipts or annual value of shipments[77] was used as a proxy.

Table G-14 aggregates the estimated economic impacts on small entities, according to the categories set out in the SISNOSE decision matrix and using a 3% discount rate. Using the decision criteria established in Table G-14, this screening analysis suggests that this rulemaking can be presumed to have no SISNOSE for the following reasons:

- About 75,167 small entities (9.8%) are not expected to incur compliance costs.
- About 691,866 small entities (90.1%) are estimated to incur compliance costs that will be less than 1% of annual sales/revenue.
- About 493 of the approximately 767,568 affected small entities (<0.06%) could incur costs in excess of 1% of annual sales/revenue. Approximately 12 small entities (<0.002%) could incur costs in excess of 3% of annual sales/revenue. These estimates are below the thresholds for a substantial number determination (i.e., between 100 and 999 entities and less than 20% of affected entities).

Table G-14 - Aggregated Economic Impacts on Small Entities with 3% Discount Rate

Economic Impact	Entity Type	Number of Small Entities Subject to the Rule and Experiencing Given Economic Impact	Percent of All Small Entities Subject to the Rule
Less than 1% for all affected small entities [a]	Accommodations	8,522	
	Agriculture and Crop Support Services	3,008	
	Arts, Entertainment, and Recreation	181	
	Beverage & Ice Manufacturing	417	
	Charter Bus Industry	83	
	City Government	2,276	

[77] Total value of shipments includes the received or receivable net selling values of all products shipped (excluding freight and taxes).

Economic Impact	Entity Type	Number of Small Entities Subject to the Rule and Experiencing Given Economic Impact	Percent of All Small Entities Subject to the Rule
	Disposal and Recycling Facilities	1,541	
	Durable Goods Wholesalers and Dealers	230	
	Educational Services	163	
	Electronics Manufacturing	1,563	
	Fire Suppression Manufacturers	8	
	Fitness and Recreational Sports	35	
	Food Manufacturing	2,130	
	Grocery & Specialty Food Stores	48,338	
	Hospitals	354	
	Materials Recovery Facilities (Reclaimers)	32	
	Non-durable Goods Wholesalers and Dealers	2,327	
	Non-Food Manufacturing	20,462	
	Office Buildings	1,778	
	Other Chemical and Allied Products Merchant Wholesalers	2,030	
	Other Warehousing, Storage, and Transportation	13,721	
	Petrochemical Manufacturing	6	
	Refrigerant Technicians	49,964	

Economic Impact	Entity Type	Number of Small Entities Subject to the Rule and Experiencing Given Economic Impact	Percent of All Small Entities Subject to the Rule
	Refrigerated Warehousing and Storage	397	
	Refrigeration Equipment and Supplies Merchant Wholesalers	238	
	Restaurants and Food Services	488,180	
	School Districts	12,187	
	Support Activities for Transportation	218	
	Telecommunications and Information Services	29,695	
	Utilities	1,226	
	Warm Air Heating and Air-Conditioning Equipment and Supplies Merchant Wholesalers	597	
	Total	**691,908**	**90.1%**
1% or more for one or more affected small entities [b]	Agriculture and Crop Support Services	7	
	Arts, Entertainment, and Recreation	<5	
	Beverage & Ice Manufacturing	7	
	Charter Bus Industry	<5	
	Durable Goods	7	
	Educational Services	12	

Economic Impact	Entity Type	Number of Small Entities Subject to the Rule and Experiencing Given Economic Impact	Percent of All Small Entities Subject to the Rule
	Food manufacturing	49	
	Grocery & Specialty Food Stores	217	
	Non-durable Goods	37	
	Non-food Manufacturing	72	
	Office Buildings	17	
	Other Warehousing, Storage, and Transportation	38	
	Refrigerated Warehousing and Storage	<5	
	Utilities	25	
	Total	**493**	**0.06%**
3% or more for one or more affected small entities [b]	Durable Goods	<5	
	Non-durable Goods	<5	
	Office Buildings	<5	
	Utilities	9	
	Total	**12**	**<0.01%**

Totals may not sum due to independent rounding.

[a] Represents small entities affected with an economic impact equal to or less than 1% but greater than 0%. Approximately 75,209 affected small businesses—or 9.8 percent—would be expected to experience negligible to net positive (i.e., cost-saving) impacts.

[b] This category aggregates the number of small entities that would be expected to experience an impact of 1% to 3% with the number of small entities that would be expected to experience an impact of 3% or greater.

Additional References

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Appendix H. Industries Affected by This Rule

Table H-1: NAICS Classifications of Potentially Affected Entities

NAICS Code	NAICS Industry Description
236118	Residential Remodelers
236220	Commercial and Institutional Building Construction
238220	Plumbing, Heating, and Air-Conditioning Contractors
238990	All Other Specialty Trade Contractors
311812	Commercial Bakeries
321999	All Other Miscellaneous Wood Product Manufacturing
322299	All Other Converted Paper Product Manufacturing
324191	Petroleum Lubricating Oil and Grease Manufacturing
324199	All Other Petroleum and Coal Products Manufacturing
325199	All Other Basic Organic Chemical Manufacturing
325211	Plastics Material and Resin Manufacturing
325412	Pharmaceutical Preparation Manufacturing
325414	Biological Product (except Diagnostic) Manufacturing
325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing
326299	All Other Rubber Product Manufacturing
327999	All Other Miscellaneous Nonmetallic Mineral Product Manufacturing
332812	Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers
332999	All Other Miscellaneous Fabricated Metal Product Manufacturing
333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing
333511	Industrial Mold Manufacturing
333912	Air and Gas Compressor Manufacturing
333999	All Other Miscellaneous General Purpose Machinery Manufacturing
334413	Semiconductor and Related Device Manufacturing
334419	Other Electronic Component Manufacturing
334516	Analytical Laboratory Instrument Manufacturing
335220	Major Household Appliance Manufacturing

NAICS Code	NAICS Industry Description
336120	Heavy Duty Truck Manufacturing
336212	Truck Trailer Manufacturing
336214	Travel Trailer and Camper Manufacturing
3363	Motor Vehicle Parts Manufacturing
3364	Aerospace Product and Parts Manufacturing
336411	Aircraft Manufacturing
336611	Ship Building and Repairing
336612	Boat Building
339112	Surgical and Medical Instrument Manufacturing
339113	Surgical Appliance and Supplies Manufacturing
339999	All Other Miscellaneous Manufacturing
423120	Motor Vehicle Supplies and New Parts Merchant Wholesalers
423450	Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers
423610	Electrical Apparatus and Equipment, Wiring Supplies, and Related Equipment Merchant Wholesalers
423620	Household Appliances, Electric Housewares, and Consumer Electronics Merchant Wholesalers
423690	Other Electronic Parts and Equipment Merchant Wholesalers
423720	Plumbing and Heating Equipment and Supplies (Hydronics) Merchant Wholesalers
423730	Warm Air Heating and Air-Conditioning Equipment and Supplies Merchant Wholesalers
423740	Refrigeration Equipment and Supplies Merchant Wholesalers
423830	Industrial Machinery and Equipment Merchant Wholesalers
423840	Industrial Supplies Merchant Wholesalers
423850	Service Establishment Equipment and Supplies Merchant Wholesalers
423860	Transportation Equipment and Supplies (except Motor Vehicle) Merchant Wholesalers
423990	Other Miscellaneous Durable Goods Merchant Wholesalers
424690	Other Chemical and Allied Products Merchant Wholesalers
424820	Wine and Distilled Alcoholic Beverage Merchant Wholesalers
441310	Automotive Parts and Accessories Stores

NAICS Code	NAICS Industry Description
443141	Household Appliance Stores
444190	Other Building Material Dealers
445110	Supermarkets and Other Grocery (except Convenience) Stores
445131	Convenience Retailers
445298	All Other Specialty Food Retailers
446191	Food (Health) Supplement Stores
449210	Electronics and Appliance Retailers
452311	Warehouse Clubs and Supercenters
453998	All Other Miscellaneous Store Retailers (except Tobacco Stores)
45711	Gasoline Stations With Convenience Stores
481111	Scheduled Passenger Air Transportation
488510	Freight Transportation Arrangement
493110	General Warehousing and Storage
531120	Lessors of Nonresidential Buildings (except Mini warehouses)
541330	Engineering Services
541380	Testing Laboratories
541512	Computer Systems Design Services
541519	Other Computer Related Services
541620	Environmental Consulting Services
561210	Facilities Support Services
561910	Packaging and Labeling Services
561990	All Other Support Services
562111	Solid Waste Collection
562211	Hazardous Waste Treatment and Disposal
562920	Materials Recovery Facilities
621498	All Other Outpatient Care Centers
621999	All Other Miscellaneous Ambulatory Health Care Services
72111	Hotels (Except Casino Hotels) and Motels
72112	Casino Hotels

NAICS Code	NAICS Industry Description
72241	Drinking Places (Alcoholic Beverages)
722511	Full-service Restaurants
722513	Limited-Service Restaurants
722514	Cafeterias, Grill Buffets, and Buffets
722515	Snack and Nonalcoholic Beverage Bars
81119	Other Automotive Repair and Maintenance
811219	Other Electronic and Precision Equipment Repair and Maintenance
811412	Appliance Repair and Maintenance
922160	Fire Protection

Appendix I. Interim SC-HFC Estimates

Note that the tables in this appendix are replicated from Appendix E in the Allocation Framework Rule RIA updated to 2022$. The SC-HFC estimates are presented in 2022 dollars per metric ton of HFC emitted by year.

Table I-1: SC-HFC-32 (2022$)

	Discount rate and statistic			
Year	**2.5%**	**3%**	**3% 95th Percentile**	**5%**
2020	55733.93	42967.93	113616.38	20544.57
2021	57554.74	44512.12	117879.01	21468.90
2022	59375.56	46056.31	122141.64	22393.22
2023	61196.37	47600.50	126404.27	23317.55
2024	63017.18	49144.69	130666.89	24241.87
2025	64838.00	50688.88	134929.52	25166.20
2026	66796.16	52358.05	139406.71	26178.20
2027	68754.32	54027.22	143883.90	27190.20
2028	70712.48	55696.40	148361.09	28202.20
2029	72670.64	57365.57	152838.28	29214.19
2030	74628.80	59034.75	157315.47	30226.19
2031	76911.39	61011.37	163114.11	31479.78
2032	79193.98	62987.99	168912.75	32733.37

2033	81476.57	64964.61	174711.39	33986.96
2034	83759.15	66941.23	180510.03	35240.55
2035	86041.74	68917.85	186308.67	36494.13
2036	88481.38	71033.62	192381.37	37843.42
2037	90921.01	73149.39	198454.07	39192.72
2038	93360.65	75265.16	204526.77	40542.01
2039	95800.28	77380.93	210599.47	41891.30
2040	98239.92	79496.70	216672.18	43240.59
2041	100811.58	81776.70	223487.96	44792.58
2042	103383.24	84056.70	230303.75	46344.57
2043	105954.90	86336.70	237119.54	47896.57
2044	108526.56	88616.70	243935.33	49448.56
2045	111098.22	90896.70	250751.12	51000.55
2046	113832.31	93321.26	257460.90	52652.80
2047	116566.41	95745.83	264170.69	54305.04
2048	119300.51	98170.39	270880.48	55957.29
2049	122034.61	100594.96	277590.26	57609.53
2050	124768.70	103019.52	284300.05	59261.78

Table I-2: SC-HFC-125 (2022$)

	Discount rate and statistic			
Year	**2.5%**	**3%**	**3% 95th Percentile**	**5%**
2020	321682.24	236106.62	617916.46	92801.00
2021	330113.81	243017.79	637636.30	96408.17
2022	338545.38	249928.97	657356.14	100015.33
2023	346976.95	256840.15	677075.98	103622.49
2024	355408.52	263751.32	696795.82	107229.66
2025	363840.09	270662.50	716515.66	110836.82
2026	372882.44	278100.74	736313.10	114761.22
2027	381924.78	285538.98	756110.54	118685.62
2028	390967.13	292977.21	775907.98	122610.03
2029	400009.48	300415.45	795705.42	126534.43
2030	409051.83	307853.69	815502.85	130458.83
2031	418587.19	315870.10	837880.27	134988.53
2032	428122.56	323886.51	860257.68	139518.24
2033	437657.92	331902.92	882635.10	144047.94
2034	447193.29	339919.33	905012.51	148577.64
2035	456728.65	347935.74	927389.93	153107.34

2036	467095.25	356619.18	951131.37	157996.87
2037	477461.84	365302.62	974872.80	162886.40
2038	487828.43	373986.06	998614.24	167775.93
2039	498195.02	382669.49	1022355.68	172665.46
2040	508561.61	391352.93	1046097.11	177554.99
2041	518723.97	400057.80	1069610.97	182831.16
2042	528886.32	408762.68	1093124.83	188107.32
2043	539048.67	417467.55	1116638.70	193383.49
2044	549211.02	426172.42	1140152.56	198659.65
2045	559373.38	434877.30	1163666.42	203935.82
2046	570017.73	444056.32	1186714.87	209553.62
2047	580662.09	453235.35	1209763.32	215171.42
2048	591306.44	462414.37	1232811.77	220789.21
2049	601950.79	471593.40	1255860.21	226407.01
2050	612595.15	480772.42	1278908.66	232024.81

Table I-3: SC-HFC-134a (2022$)

	Discount rate and statistic			
Year	**2.5%**	**3%**	**3% 95th Percentile**	**5%**
2020	128956.54	97527.02	255715.50	42820.40
2021	132802.52	100735.17	264718.10	44616.78
2022	136648.50	103943.32	273720.70	46413.16
2023	140494.48	107151.47	282723.30	48209.55
2024	144340.47	110359.62	291725.90	50005.93
2025	148186.45	113567.77	300728.50	51802.32
2026	152352.92	117050.87	310239.57	53767.99
2027	156519.39	120533.97	319750.63	55733.67
2028	160685.86	124017.07	329261.69	57699.34
2029	164852.34	127500.17	338772.75	59665.02
2030	169018.81	130983.27	348283.82	61630.70
2031	173522.07	134824.42	359243.95	63935.01
2032	178025.34	138665.57	370204.08	66239.33
2033	182528.60	142506.72	381164.21	68543.65
2034	187031.87	146347.87	392124.34	70847.96
2035	191535.13	150189.02	403084.47	73152.28
2036	196341.40	154302.19	414341.34	75637.90
2037	201147.68	158415.37	425598.22	78123.51
2038	205953.95	162528.54	436855.09	80609.13
2039	210760.22	166641.71	448111.96	83094.75

2040	215566.49	170754.89	459368.83	85580.37
2041	220151.85	174773.25	469978.32	88194.69
2042	224737.21	178791.61	480587.82	90809.02
2043	229322.57	182809.97	491197.31	93423.34
2044	233907.93	186828.33	501806.80	96037.67
2045	238493.29	190846.69	512416.29	98651.99
2046	243358.39	195121.15	523311.11	101444.82
2047	248223.48	199395.61	534205.92	104237.65
2048	253088.58	203670.07	545100.73	107030.49
2049	257953.68	207944.54	555995.54	109823.32
2050	262818.78	212219.00	566890.36	112616.15

Table I-4: SC-HFC-143a (2022$)

Year	Discount rate and statistic 2.5%	3%	3% 95th Percentile	5%
2020	421132.12	299173.31	783238.95	106080.33
2021	431142.84	307198.96	806745.77	110005.01
2022	441153.56	315224.60	830252.59	113929.69
2023	451164.29	323250.25	853759.41	117854.37
2024	461175.01	331275.89	877266.23	121779.05
2025	471185.74	339301.54	900773.05	125703.73
2026	481799.68	347864.64	923395.31	129951.27
2027	492413.63	356427.74	946017.57	134198.81
2028	503027.57	364990.84	968639.82	138446.35
2029	513641.52	373553.94	991262.08	142693.89
2030	524255.46	382117.03	1013884.34	146941.43
2031	535361.32	391278.26	1038533.32	151839.09
2032	546467.18	400439.49	1063182.30	156736.75
2033	557573.04	409600.72	1087831.27	161634.40
2034	568678.90	418761.95	1112480.25	166532.06
2035	579784.75	427923.18	1137129.23	171429.72
2036	591602.07	437692.16	1162875.92	176677.98
2037	603419.40	447461.14	1188622.60	181926.23
2038	615236.72	457230.12	1214369.29	187174.49
2039	627054.04	466999.10	1240115.98	192422.75
2040	638871.36	476768.08	1265862.66	197671.01
2041	650640.86	486712.46	1293311.44	203452.05
2042	662410.35	496656.84	1320760.22	209233.09
2043	674179.85	506601.23	1348209.00	215014.13
2044	685949.35	516545.61	1375657.78	220795.17
2045	697718.84	526489.99	1403106.56	226576.21
2046	710175.88	537037.69	1431859.80	232726.23
2047	722632.92	547585.38	1460613.04	238876.25
2048	735089.95	558133.08	1489366.29	245026.27
2049	747546.99	568680.77	1518119.53	251176.30
2050	760004.02	579228.46	1546872.77	257326.32

Table I-5: SC-HFC-152a (2022$)

Year	Discount rate and statistic 2.5%	3%	3% 95th Percentile	5%
2020	7756.57	6000.16	15853.35	2938.14
2021	8011.03	6217.38	16457.20	3071.55
2022	8265.50	6434.60	17061.05	3204.96
2023	8519.96	6651.82	17664.91	3338.38
2024	8774.42	6869.04	18268.76	3471.79
2025	9028.88	7086.26	18872.61	3605.21
2026	9304.30	7322.12	19493.32	3751.50
2027	9579.73	7557.99	20114.03	3897.79
2028	9855.15	7793.86	20734.74	4044.08
2029	10130.57	8029.73	21355.45	4190.38
2030	10406.00	8265.59	21976.16	4336.67
2031	10731.00	8548.40	22805.88	4519.51
2032	11056.01	8831.21	23635.59	4702.35
2033	11381.01	9114.02	24465.31	4885.19
2034	11706.01	9396.83	25295.02	5068.03
2035	12031.02	9679.64	26124.74	5250.87
2036	12378.80	9982.48	26985.45	5447.56
2037	12726.58	10285.31	27846.17	5644.26
2038	13074.37	10588.15	28706.88	5840.95
2039	13422.15	10890.99	29567.60	6037.65
2040	13769.93	11193.83	30428.32	6234.34
2041	14184.53	11559.71	31588.17	6482.08
2042	14599.12	11925.58	32748.03	6729.82
2043	15013.71	12291.46	33907.88	6977.56
2044	15428.31	12657.33	35067.74	7225.30
2045	15842.90	13023.21	36227.59	7473.03
2046	16279.77	13409.45	37375.91	7735.42
2047	16716.64	13795.69	38524.22	7997.81
2048	17153.51	14181.93	39672.54	8260.20
2049	17590.38	14568.18	40820.85	8522.59
2050	18027.25	14954.42	41969.17	8784.98

Table I-6: SC-HFC-227ea (2022$)

Year	Discount rate and statistic

	2.5%	3%	3% 95th Percentile	5%
2020	297055.07	216155.46	566455.49	82545.11
2021	304615.60	222319.00	583582.24	85705.12
2022	312176.14	228482.54	600708.99	88865.14
2023	319736.68	234646.07	617835.74	92025.15
2024	327297.22	240809.61	634962.49	95185.17
2025	334857.75	246973.15	652089.25	98345.18
2026	342938.85	253590.74	669863.24	101778.56
2027	351019.95	260208.32	687637.24	105211.95
2028	359101.05	266825.91	705411.23	108645.33
2029	367182.15	273443.50	723185.23	112078.72
2030	375263.25	280061.09	740959.23	115512.10
2031	383757.34	287172.74	760683.78	119472.00
2032	392251.43	294284.39	780408.34	123431.90
2033	400745.53	301396.05	800132.90	127391.81
2034	409239.62	308507.70	819857.46	131351.71
2035	417733.71	315619.36	839582.01	135311.61
2036	426854.89	323251.93	860042.27	139569.23
2037	435976.06	330884.50	880502.52	143826.85
2038	445097.23	338517.07	900962.77	148084.47
2039	454218.40	346149.64	921423.03	152342.09
2040	463339.57	353782.21	941883.28	156599.71
2041	472317.41	361466.19	961555.81	161220.41
2042	481295.25	369150.17	981228.35	165841.11
2043	490273.09	376834.15	1000900.88	170461.81
2044	499250.93	384518.13	1020573.42	175082.51
2045	508228.77	392202.11	1040245.95	179703.20
2046	517791.18	400395.42	1061935.84	184636.50
2047	527353.59	408588.73	1083625.74	189569.80
2048	536916.00	416782.04	1105315.63	194503.10
2049	546478.41	424975.35	1127005.53	199436.40
2050	556040.82	433168.66	1148695.42	204369.70

Table I-7: SC-HFC-236fa (2022$)

	Discount rate and statistic			
Year	2.5%	3%	3% 95th Percentile	5%

2020	1088012.51	711629.23	1871276.22	204546.68
2021	1109343.77	727899.70	1917560.99	211581.34
2022	1130675.03	744170.17	1963845.75	218616.00
2023	1152006.30	760440.64	2010130.52	225650.66
2024	1173337.56	776711.11	2056415.29	232685.32
2025	1194668.83	792981.57	2102700.05	239719.98
2026	1217267.97	810303.11	2149615.48	247294.82
2027	1239867.12	827624.64	2196530.90	254869.67
2028	1262466.26	844946.17	2243446.33	262444.51
2029	1285065.40	862267.70	2290361.76	270019.35
2030	1307664.55	879589.24	2337277.18	277594.19
2031	1331403.16	898146.01	2391611.16	286386.37
2032	1355141.77	916702.79	2445945.13	295178.55
2033	1378880.39	935259.56	2500279.11	303970.72
2034	1402619.00	953816.34	2554613.08	312762.90
2035	1426357.61	972373.12	2608947.06	321555.08
2036	1451306.91	991960.75	2665502.72	330905.26
2037	1476256.21	1011548.39	2722058.39	340255.44
2038	1501205.50	1031136.02	2778614.05	349605.62
2039	1526154.80	1050723.66	2835169.72	358955.81
2040	1551104.10	1070311.29	2891725.38	368305.99
2041	1576689.31	1090753.23	2950311.80	378894.63
2042	1602274.52	1111195.18	3008898.23	389483.28
2043	1627859.73	1131637.12	3067484.65	400071.93
2044	1653444.95	1152079.06	3126071.07	410660.57
2045	1679030.16	1172521.00	3184657.49	421249.22
2046	1705768.95	1193986.92	3244613.16	432431.27
2047	1732507.75	1215452.83	3304568.83	443613.32
2048	1759246.54	1236918.74	3364524.50	454795.37
2049	1785985.34	1258384.65	3424480.18	465977.43
2050	1812724.13	1279850.56	3484435.85	477159.48

Table I-8: SC-HFC-245fa (2022$)

	Discount rate and statistic			
Year	2.5%	3%	3% 95th Percentile	5%
2020	89468.00	68623.70	180669.87	32002.52
2021	92309.89	71025.77	187355.76	33413.51
2022	95151.78	73427.84	194041.64	34824.49
2023	97993.67	75829.91	200727.53	36235.47
2024	100835.57	78231.98	207413.41	37646.46
2025	103677.46	80634.05	214099.30	39057.44
2026	106746.93	83237.14	221092.99	40601.70
2027	109816.41	85840.24	228086.68	42145.96
2028	112885.88	88443.34	235080.38	43690.22
2029	115955.36	91046.44	242074.07	45234.48
2030	119024.84	93649.54	249067.76	46778.74
2031	122498.30	96647.08	257844.49	48651.65
2032	125971.76	99644.61	266621.22	50524.56
2033	129445.22	102642.15	275397.95	52397.47
2034	132918.68	105639.69	284174.67	54270.39
2035	136392.14	108637.22	292951.40	56143.30
2036	140152.58	111877.65	302104.63	58168.31
2037	143913.02	115118.08	311257.87	60193.32
2038	147673.45	118358.51	320411.10	62218.32
2039	151433.89	121598.93	329564.33	64243.33
2040	155194.33	124839.36	338717.56	66268.34
2041	158869.74	128085.15	347843.81	68456.07
2042	162545.16	131330.93	356970.05	70643.79
2043	166220.58	134576.72	366096.30	72831.52
2044	169895.99	137822.50	375222.54	75019.24
2045	173571.41	141068.29	384348.79	77206.96
2046	177533.63	144563.42	393792.21	79557.03
2047	181495.86	148058.56	403235.62	81907.09
2048	185458.08	151553.70	412679.04	84257.16
2049	189420.31	155048.84	422122.46	86607.23
2050	193382.53	158543.98	431565.88	88957.29

Table I-9: SC-HFC-43-10mee (2022$)

	Discount rate and statistic			
Year	2.5%	3%	3% 95th Percentile	5%
2020	148861.07	112098.04	293905.01	48396.89
2021	153189.60	115704.38	303937.05	50397.59
2022	157518.13	119310.71	313969.08	52398.29
2023	161846.66	122917.04	324001.11	54399.00
2024	166175.18	126523.38	334033.15	56399.70
2025	170503.71	130129.71	344065.18	58400.40
2026	175209.52	134052.62	354910.00	60589.73
2027	179915.33	137975.52	365754.83	62779.05
2028	184621.14	141898.43	376599.65	64968.38
2029	189326.94	145821.33	387444.47	67157.71
2030	194032.75	149744.24	398289.30	69347.03
2031	199086.33	154044.72	410454.48	71902.31
2032	204139.91	158345.21	422619.66	74457.59
2033	209193.49	162645.69	434784.85	77012.87
2034	214247.07	166946.18	446950.03	79568.15
2035	219300.64	171246.66	459115.21	82123.42
2036	224676.69	175840.53	471633.00	84877.15
2037	230052.73	180434.41	484150.78	87630.88
2038	235428.77	185028.28	496668.56	90384.61
2039	240804.81	189622.15	509186.34	93138.33
2040	246180.86	194216.03	521704.12	95892.06
2041	251333.77	198722.44	533472.51	98795.21
2042	256486.69	203228.85	545240.89	101698.35
2043	261639.61	207735.27	557009.28	104601.49
2044	266792.53	212241.68	568777.66	107504.64
2045	271945.45	216748.09	580546.05	110407.78
2046	277436.76	221555.48	592857.92	113511.21
2047	282928.07	226362.87	605169.80	116614.65
2048	288419.39	231170.26	617481.67	119718.08
2049	293910.70	235977.65	629793.55	122821.51
2050	299402.01	240785.04	642105.42	125924.94

Table I-10: SC-HFC-23 (2022$)

	Discount rate and statistic			
Year	2.5%	3%	3% 95th Percentile	5%
2020	1660692.00	1081400.12	2873037.41	307668.79
2021	1693043.33	1106002.65	2942537.52	318230.46
2022	1725394.67	1130605.18	3012037.62	328792.13
2023	1757746.01	1155207.71	3081537.72	339353.80
2024	1790097.35	1179810.24	3151037.83	349915.47
2025	1822448.69	1204412.77	3220537.93	360477.14
2026	1856630.60	1230554.11	3292420.73	371844.71
2027	1890812.51	1256695.46	3364303.54	383212.29
2028	1924994.42	1282836.81	3436186.35	394579.86
2029	1959176.32	1308978.15	3508069.15	405947.44
2030	1993358.23	1335119.50	3579951.96	417315.01
2031	2029297.80	1363149.94	3662535.07	430524.12
2032	2065237.36	1391180.39	3745118.17	443733.22
2033	2101176.93	1419210.84	3827701.28	456942.33
2034	2137116.49	1447241.28	3910284.39	470151.43
2035	2173056.06	1475271.73	3992867.50	483360.54
2036	2210881.02	1504905.18	4077606.29	497436.61
2037	2248705.98	1534538.63	4162345.07	511512.68
2038	2286530.94	1564172.08	4247083.86	525588.75
2039	2324355.91	1593805.53	4331822.65	539664.81
2040	2362180.87	1623438.98	4416561.43	553740.88
2041	2400988.05	1654369.62	4507297.75	569678.01
2042	2439795.23	1685300.26	4598034.07	585615.13
2043	2478602.40	1716230.90	4688770.38	601552.25
2044	2517409.58	1747161.54	4779506.70	617489.38
2045	2556216.76	1778092.18	4870243.01	633426.50
2046	2596764.24	1810549.89	4963028.17	650233.41
2047	2637311.71	1843007.60	5055813.32	667040.33
2048	2677859.19	1875465.31	5148598.47	683847.25
2049	2718406.67	1907923.02	5241383.62	700654.16
2050	2758954.14	1940380.73	5334168.77	717461.08

Appendix J. Updated SC-GHG Estimates

EPA calculated updated estimates of the SC-HFCs consistent with the methodology set forth in the *EPA Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances* (EPA, 2023. See EPA (2023) for a full explanation of the updated methodology and how the updated SC-GHG estimates differ from those produced under the IWG (2021) methods. To recover updated estimates of the SC-HFCs for this rule consistent with EPA (2023c), several modifications were necessary. First, background emissions trajectories for HFC-236fa were added to the climate module (FaIR1.6.2) using the SSP2-4.5 storyline scenario; the other 7 HFCs affected by this rule were already contained within the climate module and are also drawn from SSP2-4.5. Second, the sea-level rise module underlying the DSCIM damage module (FACTS) has been updated to directly estimate changes in sea-level rise from probabilistic socioeconomics and emissions scenarios (i.e., RFF-SPs), as opposed to the use of an emulator as was done in EPA (2023c). Additional documentation and full replication of the models and their estimates are available at www.github.com/USEPA/schfc as well as in file [] within the docket. Table J-1 presents the climate benefits from the final ER&R rule using the updated SC-HFC estimates for each gas in 2022$.

Table J-1: *Undiscounted Monetized Climate Benefits (2022$)*[a,b,c]

	Base Case Incremental Climate Benefits (millions 2022$)		
	Near-Term Ramsey Discount Rate		
Year	***1.5%***	***2%***	***2.5%***
2024	$0.00	$0.00	$0.00
2025	$0.00	$0.00	$0.00
2026	$997.99	$709.87	$530.30
2027	$1,160.59	$828.56	$620.87
2028	$1,568.54	$1,127.92	$851.44
2029	$1,552.54	$1,120.79	$848.93
2030	$1,532.26	$1,110.17	$843.53
2031	$1,514.15	$1,101.36	$839.70
2032	$1,492.14	$1,089.39	$833.25
2033	$1,471.79	$1,078.23	$827.15
2034	$1,438.29	$1,057.41	$813.67
2035	$1,372.76	$1,012.79	$781.75
2036	$1,306.81	$967.44	$749.01
2037	$1,237.66	$919.32	$713.87

2038	$1,166.85	$869.62	$677.28
2039	$1,094.64	$818.55	$639.44
2040	$1,022.26	$767.04	$601.06
2041	$960.69	$723.51	$568.79
2042	$868.87	$657.14	$518.62
2043	$785.05	$596.47	$472.74
2044	$720.06	$549.87	$437.87
2045	$665.53	$510.83	$408.71
2046	$620.16	$478.40	$384.54
2047	$581.69	$450.98	$364.19
2048	$551.09	$429.35	$348.29
2049	$530.11	$414.89	$337.95
2050	$524.46	$411.81	$336.37
PV	**$22,178.84**	**$15,424.50**	**$11,228.45**
EAV	**$1,070.43**	**$789.83**	**$609.43**

[a] Rows may not appear to add correctly due to rounding.
[b] Present values are calculated using end of year discounting.
[c] The equivalent annual values of benefits are calculated over a 25-year period.

Appendix K. Cost of Reclaim/Recycled HFCs Sensitivity Results

In the base case scenario, EPA assumed reclaimed/recycled HFCs to be 10% more expensive than virgin HFCs. This was chosen as a conservative measure to prevent underestimating the total cost. However, as pointed out by comments received under the Notice of Proposed Rulemaking (NPRM), the cost of reclaim may be closer to parity with virgin manufacture. Thus, EPA ran an additional analysis where reclaimed/recycled HFCs cost were equivalent to virgin HFCs. The results for this analysis are shown in Table K-1.

Table K-1 – Difference in annual incremental cost for all MAC options for different reclaim costs (millions of 2022$, discounted to 2024)[a,b,c]

Cost of Reclaim Sensitivity Analysis			
Year	***Reclaim > Virgin (Base Case)***	***Reclaim = Virgin***	***% Change***
2026	$79.71	$79.52	-0.2%
2027	$111.60	$111.40	-0.2%
2028	$93.49	$93.28	-0.2%
2029	$95.06	$91.42	-3.8%
2030	$93.05	$88.95	-4.4%
2031	$90.45	$86.49	-4.4%
2032	$87.51	$83.69	-4.4%

2033	$84.71			$81.01			-4.4%		
2034	$83.03			$79.46			-4.3%		
2035	$79.05			$75.58			-4.4%		
2036	$75.15			$71.79			-4.5%		
2037	$71.65			$68.41			-4.5%		
2038	$68.09			$64.95			-4.6%		
2039	$64.46			$61.44			-4.7%		
2040	$60.77			$57.87			-4.8%		
2041	$57.99			$55.22			-4.8%		
2042	$53.45			$50.79			-5.0%		
2043	$49.80			$47.22			-5.2%		
2044	$47.86			$45.26			-5.4%		
2045	$46.22			$43.60			-5.7%		
2046	$46.01			$43.37			-5.7%		
2047	$45.90			$43.24			-5.8%		
2048	$45.91			$43.22			-5.9%		
2049	$46.02			$43.31			-5.9%		
2050	$46.24			$43.51			-5.9%		
DR	**2%**	**3%**	**7%**	**2%**	**3%**	**7%**	**2%**	**3%**	**7%**
PV	$1,343	$1,196	$790	$1,292	$1,151	$764	-3.8%	-3.7%	-3.4%
EAV	$68.80	$68.69	$67.80	$66.17	$66.13	$65.52	-3.8%	-3.7%	-3.4%

[a] The first scenario represents the base case which assumes a 10% markup on the cost of reclaim. The second scenario assumes the reclaim and virgin HFCs are equivalent in cost.
[b] Present values are calculated using end of year discounting.
[c] The equivalent annual values of benefits are calculated over a 25-year period.

When assuming reclaim parity with virgin, annual incremental costs fall by $0.11 M to $2.44 M (0% to 5% decrease). However, when compared to the total cost of the rule this represents only a marginal decrease of ~2%.

Appendix L. Alternative Equipment Age Requirements for ALD

The EPA considered different equipment age cutoffs for the ALD requirement in this rule beyond new CR and IPR refrigerant-containing appliances, which are required to install the ALD system within 30 days of installation. Additional analyses were with equipment age thresholds of 5 years and all existing equipment in addition to the base case (10 years before the January 1, 2027 compliance date). Results are summarized in Table L-1.

Table L-1 – Difference in annual incremental cost for all MAC options for different equipment age cutoffs for the ALD requirement (millions of 2022$, discounted to 2024)

Alternative Equipment Age Requirements for ALD Sensitivity Analysis					
	Cost (2022$)			***% Change from Base Case***	
Year	***2017+ (Base Case)***	***2021+***	***All Existing***	***2021+***	***All Existing***
2026	$80	$80	$80	0.0%	0.0%
2027	$112	$92	$148	-17.4%	32.9%
2028	$93	$84	$144	-9.6%	54.0%
2029	$95	$86	$142	-9.4%	49.8%
2030	$93	$84	$137	-9.6%	47.5%
2031	$90	$82	$131	-9.8%	45.4%
2032	$88	$79	$125	-10.1%	43.2%
2033	$85	$76	$119	-10.4%	40.7%
2034	$83	$73	$113	-11.8%	35.9%
2035	$79	$70	$106	-10.8%	34.5%
2036	$75	$68	$100	-9.9%	32.7%
2037	$72	$65	$94	-8.7%	30.5%
2038	$68	$63	$87	-7.4%	28.0%
2039	$64	$61	$81	-6.0%	25.2%
2040	$61	$57	$74	-6.3%	22.0%

2041	$58			$53			$67			-8.3%			16.2%		
2042	$53			$50			$61			-7.2%			13.9%		
2043	$50			$47			$56			-5.6%			11.7%		
2044	$48			$46			$53			-3.7%			10.5%		
2045	$46			$45			$51			-1.8%			9.5%		
2046	$46			$46			$50			0.0%			8.3%		
2047	$46			$46			$49			0.0%			7.4%		
2048	$46			$46			$49			0.0%			6.6%		
2049	$46			$46			$49			0.0%			6.0%		
2050	$46			$46			$49			0.0%			5.7%		
DR	**2%**	**3%**	**7%**	**2%**	**3%**	**7%**	**2%**	**3%**	**7%**	**2%**	**3%**	**7%**	**2%**	**3%**	**7%**
PV	$1,343	$1,196	$790	$1,235	$1,098	$721	$1,746	$1,563	$1,048	-8%	-18%	-46%	30%	16%	-22%
EAV	$69	$69	$68	$63	$63	$62	$89	$90	$90	-8%	-8%	-10%	30%	30%	31%

Appendix M.Disposable Cylinder Management

Introduction

Most HFCs, including those used as refrigerants, are gases at room temperature and are typically transported and stored as compressed liquids in pressurized metal containers called cylinders. There are two primary types of cylinders. Disposable (also known as non-refillable or single-use or DOT-39) cylinders are used once before disposal, whereas refillable cylinders can be used multiple times throughout the cylinder lifetime. Disposable cylinders today are typically discarded with refrigerants still in the cylinders, including from amounts commonly referred to as heels (i.e., the small amount of refrigerant that remains in an “empty” cylinder). These residual refrigerants are emitted over time as they leak out or are expelled when the cylinder is crushed for disposal or metal recycling. So-called “30-pound” metal cylinders are most often disposable but may come in refillable designs as well and are used primarily in the stationary air-conditioning and refrigeration system servicing industry and, to a lesser extent, in motor vehicle air conditioning.

The provisions of this rule include requirements to remove the heel from used disposable cylinders before the cylinders are discarded; the requirement covers disposable cylinders used for servicing, repair, disposal, or installation of equipment. Both disposable and refillable cylinders will be available for transporting refrigerant; however, it is expected that refillable cylinders are returned and refilled several times in the baseline, and that no additional costs or benefits from refillable cylinders result based on this rule. For analytical purposes, the Agency focused on anticipated additional reductions in HFC consumption and emissions as well as industry costs and the potential savings from avoided refrigerant loss from disposable cylinders.

EPA has prepared a report, *Refrigerant Cylinders: Updated Analysis of Use, Disposal, and Distribution of Refrigerants* (EPA 2024a), analyzing the costs and benefits of the requirement that disposable cylinders that have been used for the servicing, repair, or installation of refrigerant-containing equipment be transported to an EPA-certified reclaimer, and that reclaimers or another final processor within the supply and disposal chain remove all HFCs (i.e., heel) from disposable cylinders prior to discarding the cylinder. If the heel is removed by a final processor or otherwise in the supply chain, the removed heels may be consolidated, but must be sent to an EPA-certified reclaimer or fire suppressant recycler. This appendix presents a summary of some of the results from this report and provides further analysis.

Emission Estimates for Recovery of Disposable Cylinder Heels

The report assesses the typical distribution of refrigerants in cylinders, including refrigerant changes expected under the Base Case for this rule. Heels remaining in disposable cylinders were determined through both a theoretical and empirical study. Based on the wide range of disposal practices currently employed and expected to continue in absence of this final rule, three scenarios were developed to estimate the emissions avoided: a central scenario, a low scenario (i.e., a lower heel left in the cylinder), and a high scenario.

The emissions avoided by removing such heels are dependent on the number of disposable cylinders in circulation and the average heel that would otherwise be emitted in absence of this rule. Based on the report cited above, we assume in the central scenario that there are approximately 4.5 million cylinders in circulation, of which 99% are disposable. Further, we estimate that the average heel is approximately 4% by weight of the nominal capacity (e.g. 0.96 pounds for a 24-pound cylinder).[78] We use a heel of 0.288 pounds (1.2 percent) and 1.65 pounds (6.875 percent) for the low and high scenarios, respectively. Because of the other regulations in place, it is expected that the average GWP of the refrigerant in such cylinders will decrease. Other emissions associated with cylinders—for example, during transport and storage—are not expected to change based on this rule. Based on the expected transitions from these regulations, Table M-1, below, presents the avoided emissions for the years 2028 through 2050.

Table M-1: Estimated Annual Emission Changes Compared with BAU, 2028–2050

Year	Average HFC GWP	Emission Reductions Relative to BAU ($MMTCO_2e$)		
		Central	Low	High
2028	1,547	2.27	0.68	3.90
2029	1,498	2.17	0.65	3.73
2030	1,445	2.06	0.62	3.54
2031	1,390	1.95	0.59	3.35
2032	1,332	1.84	0.55	3.17
2033	1,274	1.74	0.52	2.99
2034	1,210	1.63	0.49	2.80
2035	1,142	1.52	0.46	2.61
2036	1,071	1.41	0.42	2.42
2037	1,002	1.31	0.39	2.25
2038	945	1.22	0.37	2.10
2039	900	1.16	0.35	1.99
2040	872	1.12	0.33	1.92
2041	843	1.07	0.32	1.84
2042	814	1.03	0.31	1.77
2043	788	0.99	0.30	1.71
2044	769	0.97	0.29	1.66

[78] R-404A is typically sold in a 24-pound cylinder. Cylinders for other HFC refrigerants are typically larger, from 25 to 50 pounds. We use 24 pounds as a conservative estimate here.

Year	Average HFC GWP	Emission Reductions Relative to BAU ($MMTCO_2e$)		
		Central	Low	High
2045	753	0.94	0.28	1.62
2046	742	0.93	0.28	1.60
2047	733	0.92	0.28	1.58
2048	726	0.91	0.27	1.56
2049	720	0.90	0.27	1.55
2050	717	0.90	0.27	1.54
Total		**30.96**	**9.29**	**53.21**

Cost Estimates for Recovery of Disposable Cylinder Heels

The report also assesses the cost implications for the requirement for heel removal, accounting for the costs associated with the change in procedure handling of cylinders (i.e., returning the cylinders for heels to be removed) and the potential savings from avoided refrigerant loss from heel emissions. There are multiple paths that the cylinder may take before the heel is removed and the truly-empty cylinder is landfilled or recycled. This analysis assumes that some cylinders will be: (a) sent directly to the reclaimer; (b) returned to a wholesaler or distributor,[79] who will ship disposable cylinders to a landfill or steel recycling facility, which would combine heels for shipment to a reclaimer; and (c) shipped directly from the end-user or technician to a landfill or steel recycling facility, which would combine heels for shipment to a reclaimer. For paths (b) and (c) above, we assume the landfill or steel recycling facility would reduce costs by combining 25 refrigerant heels (at 0.96 pounds as discussed above) of each HFC or HFC substitutes containing an HFC (e.g., HFC/HFO blends) they receive into individual 24-pound cylinders before sending those to a reclaimer. After recovering heels, reclaimers are assumed to send disposable cylinders to a landfill or steel recycler.

Neat HFOs, which are not regulated substances under this rulemaking but are used in some RACHP equipment, are not accounted for in the analysis. For HFCs and HFC/HFO blends, we divide cylinders equally amongst the transportation paths described above. Thus, we assume one-third follow path (a), one-third follow path (b), and one-third follow patch (c). Table M-2 displays the estimated mileage for each leg of the paths taken compared to the business-as-usual (BAU) route.

[79] Wholesalers and distributors could also perform the heel recovery, and likewise amass heels into a single cylinder to be shipped to a reclaimer. Based on comments to the NPRM that indicate an economic disincentive to doing that at a wholesaler/distributor facility, we assume cylinders with heels received by these entities are shipped directly to the landfill or steel recycler.

Table M-2: Estimated Distances for Disposable Cylinder Transportation Compared with BAU (Miles)[a]

Transportation Leg	*BAU*	*(a) End-user to Reclaimer to Landfill*	*(b) End-user to Distributor to Reclaimer*	*© End-user to Landfill*
Producer/Filler to Wholesale Distributor	1,000	1,000	1,000	1,000
Wholesale Distributor to End User/Technician	25	25	25	25
End User/Technical to Steel Recycler/Landfill	75	NA	NA	75
End User/Technical to Reclaimer	NA	50	NA	NA
End User/Technical to Wholesale Distributor	NA	NA	25	NA
Reclaimer to Steel Recycler/Landfill	NA	75	75	NA
Landfill sending Recovered Refrigerant to Reclaimer[b]	NA	NA	75	75
Total Miles per Cylinder	**1,100**	**1,150**	**1,128**	**1,103**

[a] CARB (2011)
[b] Each cylinder sent represents 25 cylinders received with heels (Central scenario).

The additional travel costs are influenced by how many cylinders fit on a truck, the fuel to drive the extra distances, and the incremental labor for such. By removing heels that would have otherwise been emitted, an additional supply is provided that would offset virgin production providing additional benefits based on the cost of refrigerant. These assumptions are shown in Table M-3 below.

Table M-3: Additional Disposable Cylinder Cost Assumptions

Factor (units)	*Value*	*Source*	*Notes*
Cylinders per Truck	1,120	CARB (2011)	
Average Truck Speed (miles per hour)	50	CARB (2011)	
Truck Transport Labor Rate ($/hour)	$53.59	U.S. Bureau of Labor Statistics (2023b)	May 2022 mean, including 110% overhead
Average Fuel Consumption (miles per gallon)	6.1	Geotab (2017)	Average across all states
Fuel cost ($/gallon)	$4.034	EIA (2024)	Price of diesel as of March 25, 2024
Cost of HFC refrigerant ($/pound)	$4		Consistent with past AIM Act analyses

Accounting for the fuel and labor associated with the additional shipment of cylinders and the cost of refrigerants, we estimate costs and benefits, and hence the net benefits, as shown in Table M-4 for the Central scenario.

Table M-4: Costs, Benefits, and Net Benefits of Cylinder Management (Central Scenario) (Millions 2022$)[a,b]

Year	Benefits	Costs	Net Benefits
2028	$12.94	$0.14	$12.80

Year	Benefits			Costs			Net Benefits		
2029	$12.76			$0.14			$12.62		
2030	$12.57			$0.14			$12.43		
2031	$12.37			$0.13			$12.24		
2032	$12.19			$0.13			$12.06		
2033	$12.03			$0.13			$11.90		
2034	$11.88			$0.13			$11.75		
2035	$11.74			$0.13			$11.61		
2036	$11.62			$0.13			$11.49		
2037	$11.52			$0.13			$11.39		
2038	$11.43			$0.12			$11.30		
2039	$11.35			$0.12			$11.22		
2040	$11.28			$0.12			$11.16		
2041	$11.22			$0.12			$11.10		
2042	$11.16			$0.12			$11.04		
2043	$11.12			$0.12			$10.99		
2044	$11.09			$0.12			$10.97		
2045	$11.06			$0.12			$10.94		
2046	$11.05			$0.12			$10.93		
2047	$11.04			$0.12			$10.92		
2048	$11.03			$0.12			$10.91		
2049	$11.02			$0.12			$10.90		
2050	$11.02			$0.12			$10.90		
d.r.	2%	3%	7%	2%	3%	7%	2%	3%	7%
NPV	$197.1	$170.9	$101.9	$2.1	$1.9	$11	$194.9	$169.1	$100.8
EAV	$10.09	$9.82	$8.74	$0.11	$0.11	$0.095	$9.98	$9.71	$8.65

[a] Present values are calculated using end of year discounting.

[b] The equivalent annual values of benefits are calculated over a 25-year period.

Climate Benefits from Recovery of Disposable Cylinder Heels

As discussed above, as the market transitions to lower-GWP refrigerants based on the 2023 Technology Transitions Rule, the mix of regulated refrigerants will change. In general, the transition would lead to higher use of refrigerants not covered by the disposable cylinder management provision (e.g., ammonia, carbon dioxide, hydrocarbons, HFOs) and less use of regulated substances (HFCs, HFC/HFO blends). The social cost implications are determined as discussed in Section 3.5 and added to the net benefits from the above table. Table M-5 presents the emission reductions by gas, the social cost attributed to that mix of gases, and the net benefits inclusive of the social costs.

Table M-5: *Emission Reductions, Social Cost Benefits, and Net Benefits of Cylinder Management (Central Scenario)*

	Emission Reductions (Metric Tons)					Benefits (millions 2022$)	
	HFC-32	**HFC-125**	**HFC-134a**	**HFC-143a**	**HFC-245fa**	**SC Benefits**	**Net**
2028	680	332	203	81	0.44	$190	$202
2029	686	312	191	76	0.44	$186	$198
2030	693	292	176	71	0.45	$181	$193
2031	700	271	161	67	0.45	$176	$188
2032	706	249	148	63	0.45	$171	$183
2033	713	227	136	59	0.46	$166	$177
2034	720	204	126	55	0.46	$159	$171
2035	728	180	118	51	0.47	$152	$164
2036	736	156	112	46	0.47	$145	$157
2037	743	131	109	43	0.47	$139	$150
2038	749	112	105	39	0.48	$133	$145
2039	755	99	100	36	0.48	$130	$141
2040	759	93	95	32	0.48	$128	$139
2041	764	86	90	28	0.48	$126	$137
2042	769	80	85	24	0.48	$125	$136
2043	773	75	81	20	0.43	$123	$134
2044	776	73	79	17	0.34	$123	$134
2045	778	70	78	13	0.22	$123	$134
2046	780	69	76	11	0.12	$125	$135
2047	781	68	75	10	0.05	$126	$137
2048	783	67	74	8.2	0.01	$128	$139
2049	783	67	73	6.9	0	$129	$140
2050	784	67	73	6.5	0	$132	$143
Present Value (2% discount rate)						N/A	$2,360
Present Value (3% discount rate)						$2,165	$2,335
Present Value (7% discount rate)						N/A	$2,266
Equivalent Annual Value (2% discount rate)						N/A	$134
Equivalent Annual Value (3% discount rate)						$124	$134
Equivalent Annual Value (7% discount rate)						N/A	$133

Sensitivity Analyses for Recovery of Disposable Cylinder Heels

Several entities provided comments on the assumptions found in the report relied upon above (*e.g.*, Worthington, 2023). One commenter indicates the assumed number of cylinders of 4,500,000 is too low, that the heel remaining in a cylinder upon disposal of 4 percent is too high, and that the assumption that all or nearly all of such cylinders will emit the totality of the heel rather than be removed is not the case. Below we summarize the potential effects on the costs and emission reductions under alternate assumptions based on these comments.

The commenter says that their own sale of disposable cylinders is nearly 50% greater than EPA's estimate, that records indicate 3,941,577 cylinders were imported from China, and that other countries also supply an unspecified number of cylinders. Although it is not clear what percentage of these cylinders would be used for refrigerants covered by this rule, for this sensitivity analysis, we add to our central estimate a full 50% increase, plus the full number of reported cylinders from China, and we assume that the other countries contribute 1 million cylinders, for a total of 11,691,577 cylinders.

Comments also discussed the expected heel within a cylinder. One commenter indicated an estimated heel of 1.2 percent of the charged weight, while also citing various other estimates including 1.85 percent from CARB, noting this was also corroborated by the Heating, Air-conditioning and Refrigeration Distributers, International (HARDI), and 0.2 percent to 4.4 percent from Chemours, an HFC producer. Below we examine the lowest of these estimates, a 0.2 percent heel in lieu of our central estimate of 4 percent.

In addition, commenters took issue with the assumption that all cylinders will fully emit those heels. Instead, they argued that service technicians fully evacuate cylinders so that very little if any heel remains. The commenter above cited National Refrigerants, a reclaimer, stating that 90 percent of cylinders have a remaining heel of 0.5 pounds (about 2 percent) or less and that 60 percent have no discernible heel, an indication that cylinder heel removal is occurring in the field already. The commenter also pointed to CARB, which estimated that 70 percent of disposable cylinders are recycled or disposed without heel evacuation. The commenter held that it would be reasonable to assume between 10 percent and 70 percent are not properly evacuated before disposition. For this sensitivity analysis, we use the extreme conservative end of this range, i.e., 10 percent.

Table M-6 below presents the present value of the costs and the emissions avoided using the above discussed variables. Note these costs are based on handling and transportation alone, and do not include climate benefits.

Table M-6: Costs and Emission Reductions of Cylinder Management under Different Assumptions (Millions 2022$)

	Number of Cylinders	Heel	Not Vented	Benefits; NPV in 2022$ (3% discount rate, discounted to 2024)	Emission Reductions ($MMTCO_2e$)
Central Scenario	4,500,000	4%	0%	$169.1 million	30.96
Higher Cylinders	11,691,577	4%	0%	$439.3 million	80.43
Lower Heel	4,500,000	0.2%	0%	$6.69 million	1.548
Low Vented	4,500,000	4%	90%	$16.91 million	3.096
Combined	11,691,577	0.2%	90%	$1.74 million	0.402

Regulatory Option

EPA proposed that requirements for disposable cylinder management begin in 2025. For reasons stated in the final rule, EPA has removed some of those requirements and delayed the date upon which they begin to January 1, 2028. The draft RIA Addendum included with the proposed rule examined the costs and benefits of the proposed action. Table M-7 below provides the costs and emission reductions that would have been achieved under the finalized requirements with the proposed start date of 2025. The delay results in lower emission reductions and lower costs for the final rule compared to an earlier effective date as proposed.

Table M-7: Net Benefits and Emission Reductions of Cylinder Management under Different Start Years ($MMTCO_2e$, Millions 2022$)

	Effective in 2028 (final rule)	Effective in 2025 (proposed rule)	Difference	Percentage change from proposed rule start date
Emission Reductions ($MMTCO_2e$)	30.96	38.49	-7.53	-19.6%
Net Benefits[a] (millions 2022$)	$169.1	$205.3	-$36.2	-17.6%

[a]Net benefits represent the present value at a 3% discount rate discounted to 2024.

Additional References:

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Draft Technical Support Document:
Analysis of the Economic Impact and Benefits of the Final Rule: Management of Certain Hydrofluorocarbons and Substitutes Under Subsection (h) of the American Innovation and Manufacturing Act of 2020

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Stratospheric Protection Division
Office of Atmospheric Programs
1200 Pennsylvania Avenue, NW
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May 2024

Contents

List of Tables

1. List of Acronyms

AC	Air conditioning
AIM Act	American Innovation and Manufacturing Act of 2020, codified at 42 U.S.C. § 7675
ALD	Automatic Leak Detection
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BAU	Business as usual
CAA	Clean Air Act
CARB	California Air Resources Board
CC	Comfort cooling

CFC	Chlorofluorocarbon
CO_2	Carbon dioxide
CONUS	Contiguous United States
CR	Commercial refrigeration
CWA	Clean Water Act
EAV	Equivalent annualized value
EPA	Environmental Protection Agency
EO	Executive Order
ER&R	Emissions Reduction and Reclamation
GHGs	Greenhouse gases
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbon
HFCs	Hydrofluorocarbons
HFOs	Hydrofluoroolefins
ICR	Information Collection Request
IPCC	Intergovernmental Panel on Climate Change
IPR	Industrial process refrigeration
MAC	Marginal abatement cost
MACC	Marginal abatement cost curve
MT	Metric ton
$MTCO_2eq$	Metric tons of CO_2 equivalent
$MMTCO_2eq$	Million metric tons of CO_2 equivalent
NPDES	National Pollutant Discharge Elimination System
NPRM	Notice of Proposed Rulemaking
NPV	Net Present Value
ODS	Ozone-depleting substances
O&M	operations and maintenance
PV	Present value
RACHP	Refrigeration, AC, and heat pump
RCRA	Resource Conservation and Recovery Act
RIA	Regulatory Impact Analysis
RMP	Refrigerant Management Program
SBREFA	Small Business Regulatory Enforcement Fairness Act of 1996
SISNOSE	Substantial Number of Small Entities
U.S.	United States

Executive Summary

This Technical Support Document (TSD) provides an assessment of the costs and environmental impacts of the final rule implementing provisions under subsection (h) of the American Innovation and Manufacturing Act of 2020, codified at 42 U.S.C. § 7675 (AIM Act or the Act), also referred to in this document as the Emissions Reduction and Reclamation (ER&R) rule. Subsection (h) of the AIM Act, entitled "Management of regulated substances," directs the United States (U.S.) Environmental Protection Agency (EPA) to promulgate regulations to control, where appropriate, any practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment that involves: a regulated substance (used interchangeably with "HFCs" in the final rulemaking and in this TSD), a substitute for a regulated substance, the reclaiming of a regulated substance used as a refrigerant, or the reclaiming of a substitute for a regulated substance used as a refrigerant.

This rulemaking follows an already finalized rule issued separately under the AIM Act, *Phasedown of Hydrofluorocarbons: Establishing the Allowance Allocation and Trading Program Under the American Innovation and Manufacturing Act* (Allocation Framework Rule, 86 FR 55116, October 5, 2021), as well as a later rule for the same program, *Phasedown of Hydrofluorocarbons: Allowance Allocation Methodology for 2024 and Later Years* (2024 Allocation Rule, 88 FR 46836, July 20, 2023).[1] This rulemaking also follows the final rule issued under subsection (i) of the AIM Act, *Phasedown of Hydrofluorocarbons: Restrictions on the Use of Certain Hydrofluorocarbons Under the American Innovation and Manufacturing Act of 2020* (2023 Technology Transitions Rule, 88 FR 73098, October 24, 2023).[2] The analysis presented in the sections below provides estimated economic costs and environmental impacts of the provisions of the ER&R rule. The analysis also provides a comparison of these costs and environmental impacts with those assessed for the previously finalized 2023 Technology Transitions and Allocation Rules to provide the public with an understanding of any potential changes in economic and environmental impacts relative to existing regulations. Results and methods from these analyses are referenced throughout this document. As with the 2024 Allocation Rule analysis and the 2023 Technology Transitions Rule analysis, this document is presented as an addendum to the original Allocation Framework RIA.

[1] Throughout this document, we use "Allocation Framework RIA" and "2024 Allocation Rule RIA Addendum" to refer to the analyses of these rules. We use "Allocation Rules" and "Allocation Rules RIA" to refer to combined or cumulative effect of those two rules; i.e., the Allocation Framework RIA as updated by the 2024 Allocation Rule RIA Addendum.

[2] Throughout this document, we use "2023 Technology Transitions RIA" to refer to the analysis of this rule, noting this analysis included the Allocation Rules RIA as the reference case from which costs and benefits were derived.

This analysis is intended to provide the public with information on the relevant costs and environmental impacts of this rule and to comply with executive orders. While significant, the estimated costs detailed in this document are considered incidental and secondary to the rule's objectives of serving the purposes identified in subsection (h) of the AIM Act, including maximizing reclamation and minimizing releases of certain hydrofluorocarbons (HFCs) from equipment.

Environmental Impacts

One of the primary environmental impacts anticipated to result from the ER&R Rule are environmental benefits. These benefits are realized through the reduction of emissions of greenhouse gases (GHGs), specifically HFCs; GHG emissions reductions in turn contribute to reductions in damages from climate change that would have been associated with those emissions. A primary aim of the ER&R Rule is maximizing reclamation and minimizing releases of certain hydrofluorocarbons (HFCs) from equipment. Table ES-1 shows the projected incremental emission reductions by year corresponding to the ER&R Rule compliance scenario in the base case used for this analysis.

Table ES-1 – Summary of Annual Emissions Reductions for Select Years and Cumulative Total for the 2026–2050 Timeframe – Base Case Scenario

Year	Incremental Emissions Reductions (MMTEVe)
2026	5.4
2030	7.7
2035	6.1
2040	4.1
2045	2.5
2050	1.8
Total (Cumulative)	**120**

Compliance Costs

Incremental compliance costs stem from factors including industry transitions in service and maintenance practices as well as installation of equipment required to comply with provisions contained in the final rule. These include leak repair and inspection costs as well as Automatic Leak Detection (ALD) system costs for owners and operators of affected equipment. Incremental costs also stem from recordkeeping and reporting requirements detailed in the final rule. Reducing HFC emissions due to fixing leaks earlier will also be anticipated to lead to savings for some system owner/operators, as less new refrigerant would need to be purchased to replace leaked refrigerant. The estimated combined net incremental compliance costs (costs less anticipated savings) stemming from all provisions contained in the final rule are shown in Table ES-2 in 2022 dollars, discounted to 2024 at 2 percent, 3 percent, and 7 percent.[3] End of year discounting is used throughout this document. The present value of total compliance costs resulting from provisions contained in the rule is estimated to be $1.5 billion at a 2 percent discount rate, $1.3 billion at a 3 percent discount rate, or $0.9 billion at a 7 percent discount rate.

Table ES-2 – Summary of Undiscounted Annual Values, Present Values, and Equivalent Annualized Values select years for the 2026–2050 Timeframe for Estimated Compliance Costs for this Rule (millions of 2022$, discounted to 2024) – Base Case Scenario [a,b]

Year	Compliance Costs		
2026	$92		
2030	$102		
2035	$87		
2040	$67		
2045	$51		
2050	$52		
Discount rate	**2%**	**3%**	**7%**
PV	$1,499	$1,335	$884
EAV	$77	$77	$76

[a] Present values are calculated using end of year discounting.
[b] The annualized present value of costs are calculated as if they occur over a 25-year period.

Relationship to Previously Estimated Results for Allocation Rules and 2023 Technology Transitions Rules

EPA has previously estimated costs and environmental impacts of the HFC phasedown, which are detailed in the Allocation Framework RIA and 2024 Allocation Rule RIA Addendum. EPA has also estimated further incremental costs and environmental impacts of the 2023 Technology Transitions Rule, detailed in 2023 Technology Transitions Rule RIA Addendum and the association Costs and Environmental Impacts TSD. The final ER&R Rule focuses on statutory provisions under the AIM Act that are separate from those addressed in the Allocation Framework Rule and 2023 Technology Transitions Rules. However, in order to avoid double counting or overestimating of costs and environmental impacts, for the purposes of this analysis EPA's prior estimates are assumed to be the

[3] Results using the 2 percent discount rate were not included in the analysis for the proposal for this action. The 2003 version of OMB's Circular A-4 had generally recommended 3 percent and 7 percent as default rates to discount social costs and benefits. The analysis of the proposed rule used these two recommended rates. In November 2023, OMB finalized an update to Circular A-4, in which it recommended the general application of a 2 percent rate to discount social costs and benefits (subject to regular updates), which is an estimate of consumption-based discount rate. Given the substantial evidence supporting a 2 percent discount rate, we include results calculated using a 2 percent discount rate consistent with the update to Circular A-4.

status quo from which incremental environmental impacts may be calculated. Specifically, the compliance pathways and associated costs and environmental impacts evaluated in the 2023 Technology Transitions Rule RIA Addendum serve as the reference case[4] for this analysis, thus ensuring that results presented in this document are reflective of the most up-to-date policy status quo.

As detailed in the Allocation Framework Rule RIA, 2024 Allocation Rule RIA Addendum, and 2023 Technology Transitions Rule RIA Addendum, EPA relied upon a marginal abatement cost curve (MACC) approach in order to estimate the full set of industry transitions and associated compliance costs required to meet statutory requirements. Analysis for this rule builds on this previously used methodology by adding on additional measures required by the final ER&R rule and evaluating their incremental impact relative to the previously modeled set of transitions.

Results from this analysis indicate that the final rule will yield incremental HFC emissions reductions relative to the previously modeled compliance pathways.[5] However, the extent of these incremental environmental impacts depends in part on whether some of the HFC consumption- and emissions-reducing activities required by this final rule would have already been undertaken by industry in order to comply with, or otherwise address market outcomes from, the Allocation and 2023 Technology Transitions rules. As detailed in the 2023 Technology Transitions RIA Addendum, the precise set of transitions that will be undertaken by industry in response to both the Allocation and 2023 Technology Transitions Rules is uncertain, leading to a range in potential incremental environmental impacts.

For the primary, base case analysis presented in this TSD, all measures found to be required to meet compliance with the Allocation and 2023 Technology Transitions Rules, based EPA's prior analyses, are assumed to occur in the reference case. Additional measures included in EPA's prior analyses as possible industry outcomes that are not explicitly required to meet compliance with the Allocation and 2023 Technology Transitions rules are excluded. These include measures such as improvements to leak repair, enhanced recovery, and transitions in the fire suppression sector. Given the uncertainty regarding whether industry may undertake these measures in the absence of explicit requirements, in Appendix F EPA has also provided an alternative scenario where we assume that these measures do occur as reference case

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[4] Incremental costs and benefits in this analysis calculated relative to a policy status quo derived from EPA's previous analyses conducted for the Allocation and 2023 Technology Transitions Rules. This status quo is referred to as a "reference case" rather than "baseline" throughout this document to avoid confusion with the statutory baseline for the Allocation Rules.

[5] However, the schedule for the production and consumption phasedown is not made more stringent than the schedule under subsection (e)(2)(C) of the AIM Act (i.e., the production and consumption caps contained in the Allocation Rules are unchanged).

assumptions, effectively illustrating a lower-bound of the incremental environmental benefits of the final ER&R rule.

More details on these assumptions can be found in Chapter 3 as well as the appendices accompanying this document. Finally, EPA notes that these assumptions are made for technical analytic purposes and to avoid double counting of environmental impacts. They should not be interpreted as a reflection of the merits of any particular provision contained in the final rule.

Chapter 1. Introduction

1.1 Statutory Requirement

This Regulatory Impact Analysis (RIA) addendum evaluates the impact associated with the Final Rulemaking referred to in this document as the "Emissions Reduction and Reclamation" or ER&R rule. Under the American Innovation and Manufacturing Act of 2020 (the AIM) Act or the Act), the United States (U.S.) Environmental Protection Agency (EPA) is directed under subsection (h), "Management of Regulated Substances," to promulgate certain regulations for purposes that include maximizing reclamation and minimizing releases of certain hydrofluorocarbons (HFCs), those which are designated as regulated substances under the Act. Subsection (h)(1) of the AIM Act authorizes EPA to establish regulations to control, where appropriate, practices, processes, or activities regarding the servicing, repair, disposal, or installation of equipment, for purposes of maximizing the reclamation and minimizing the release of HFCs from equipment and ensuring the safety of technicians and consumers.

Among other things, subsection (h) also provides for the Agency to consider options to increase opportunities for reclaiming HFCs used as refrigerants and provides that the Agency may coordinate regulations carrying out subsection (h) of the AIM Act with similar EPA regulations. Those regulations could, for example, include those implementing the refrigerant management program established under Title VI of the Clean Air Act (CAA).

1.2 Summary of Regulatory Requirements

Pursuant to subsection (h) of the AIM Act, EPA is requiring the following:

- Applying a suite of leak repair requirements to refrigerant-containing appliances, including comfort cooling (CC) [6], commercial refrigeration (CR), and industrial process refrigeration (IPR) appliances, containing 15 or more pounds of a refrigerant containing a hydrofluorocarbon (HFCs) or a substitute for an HFC with a global warming potential (GWP) above 53 (e.g., would not apply to carbon dioxide (CO_2), ammonia, certain hydrofluoroolefins (HFOs), and other substitutes for HFCs with a GWP of 53 or below).[7] This includes:
    - Requiring annual leak inspection for all CR and IPR appliances containing 15 pounds up to 500 pounds of such refrigerant upon discovering the applicable leak rate

[6] EPA is exempting from the suite of leak repair requirements under subsection (h) any refrigerant-containing appliance used for the residential and light commercial air conditioning and heat pumps subsector.

[7] For brevity, unless otherwise stated, in this document we use the term "refrigerant" to include regulated HFCs and substitutes for HFCs with a GWP greater than 53.

threshold (20% per year and 30% per year for CR and IPR appliances, respectively) is exceeded.

- Requiring annual leak inspection for all CC and other appliances containing 15 pounds of such refrigerant upon discovering the applicable leak rate threshold (10% per year) is exceeded.
- Requiring quarterly leak inspection for all CR and IPR appliances that contain 500 pounds or more of such refrigerant upon discovering the applicable leak rate threshold is exceeded (unless ALD equipment meeting certain requirements is used for compliance).
- Requiring repair of leaks and initial and follow-up verification tests on the repairs for all appliances containing 15 or more pounds of such refrigerant (i.e., CC, CR, and IPR) when the applicable leak rate threshold is exceeded.
- Allowing owners/operators of all CC, CR, and IPR appliances containing 15 or more pounds of such refrigerant to request extensions to the leak repair and retrofit timeline.
- Applying recordkeeping and reporting requirements associated with leak inspection and leak repair to appliances containing 15 pounds or more of such refrigerant.

- Use of ALD systems for CR and IPR appliances containing 1,500 pounds or more of a refrigerant for new appliances installed on or after January 1, 2026, and for existing appliances installed on or after January 1,2017, and before January 1, 2026, as of January 1, 2027.
- Use of reclaimed refrigerant as of January 1, 2029, for servicing and/or repair of refrigerant-containing equipment in the following RACHP subsectors: supermarket systems, refrigerated transport, and automatic commercial ice makers.
- For the servicing, repair, disposal, or installation of fire suppression equipment that contains HFC, the use of recycled HFCs for the servicing and/or repair of fire suppression equipment as of January 1, 2026, and use of recycled HFCs for the initial installation of fire suppression equipment as of January 1, 2030.
- Requiring as of January 1, 2028, that disposable cylinders that have been used for the servicing, repair, or installation of refrigerant-containing equipment be transported to an entity in the supply and disposal chain (e.g., a distributor, wholesaler, refrigerant repackager, an EPA-certified reclaimer, or a landfill or metal-recovery operator) and that such entities

remove or ensure removal (e.g., by forwarding to an EPA-certified reclaimer) of all HFCs from disposable cylinders prior to discarding the cylinder.

- Requiring that disposable cylinders that have been used for the servicing, repair, or installation of fire suppression equipment be transported to a fire suppressant recycler and that fire suppressant recyclers remove all HFCs from disposable cylinders prior to discarding the cylinder.
- Finally, EPA is establishing alternative Resource Recovery and Conservation Act (RCRA) standards for ignitable spent refrigerants when recycled for reuse, as the term is to be defined under RCRA. EPA is stipulating that the 40 CFR part 266 Subpart Q RCRA alternative standards apply to HFCs and their substitutes that are lower flammability ignitable spent refrigerants.

1.3 Regulated Community

The HFC industry is composed of several types of entities. As noted in the RIA for the Allocation Framework Rule, entities potentially affected by this previous action include those that produce, import, export, destroy, use as a feedstock, reclaim, package, or otherwise distribute bulk HFCs. This analysis—which serves as an addendum to the above-mentioned Allocation Framework RIA—assesses a final rule under subsection (h) of the AIM Act that regulates certain practices, processes, or activities regarding the servicing, repair, disposal, or installation of equipment, for purposes of maximizing the reclamation and minimizing the release of HFCs from equipment and ensuring the safety of technicians and consumers. This rule affects certain entities who own, operate, service, repair, recycle, dispose, or install equipment containing HFCs or their substitutes, as well as those who recover, recycle, or reclaim HFCs or their substitutes. Manufacturers or sellers of equipment containing HFCs, or their substitutes may also be potentially affected. A detailed list of industries potentially affected by this rule can be found in Appendix H.

Chapter 2. Overview of the Analysis

2.1 Introduction

The purpose of this TSD is to provide the public with information on the relevant costs, monetary benefits, and environmental impacts (i.e., reductions in HFC consumption and emissions) of this action, as finalized, and to comply with executive orders. The document contains results of a costs and environmental impacts assessment to help EPA and the public evaluate the impact of this final rulemaking across the affected businesses. Costs presented in this analysis include compliance costs (including recordkeeping and reporting costs), monetary benefits from reduced demand for virgin HFCs, and combined net costs.

Given that the rule establishes an emissions reduction and reclamation program for the management of HFCs, which are subject to previously finalized rulemakings under the AIM Act, EPA relied on previous analyses conducted for the Allocation Framework Rule (86 FR 55116; October 5, 2021), the 2024 Allocation Rule (88 FR 46836; July 20, 2023), and 2023 Technology Transitions Rule (88 FR 73098; October 24, 2023) as a starting point for the assessment of costs and environmental impacts of this rule. We then evaluated how the provisions contained in this final rulemaking would yield potential incremental impacts.

2.2 Organization of the Analysis

The analysis contained in this document is organized as follows:

Chapter 3 summarizes key methodological assumptions relied upon for this analysis, including discussion of EPA's approach for evaluating incremental impacts relative to previous rulemakings and the marginal abatement cost (MAC) approach used for modeling the impact of regulatory requirements in this rule. Chapter 3 also summarizes assumptions and underlying data regarding the types of equipment affected by this rule. This includes equipment that relies on HFCs in the fire suppression, commercial refrigeration, industrial process refrigeration, and comfort cooling sectors. Using data from EPA's Vintaging Model, equipment is broken out by estimated average charge size (in pounds of refrigerant) and assumed leak rate.

Chapter 4 provides an assessment of the anticipated compliance costs resulting from the requirements contained in the final rule, including results from the MAC modeling approach. Estimated incremental costs are relative to those previously estimated by EPA for the Allocation and 2023 Technology Transitions Rules.

Chapter 5 provides an assessment of the anticipated environmental impacts resulting from the requirements contained in the final rule. As with results in chapter 4, estimated incremental environmental impacts are relative to those previously estimated by EPA for the Allocation and 2023 Technology Transitions Rules.

Appendices A and B provide details on underlying data and assumptions used to estimate the costs and benefits of leak repair and inspection provisions contained in the final rule and the specific leak rate assumptions derived from EPA's Vintaging Model.

Appendix C provides detailed cost estimates by equipment category for the leak repair and inspection provisions contained in the final rule. These estimates were used to model abatement costs on a dollar-per-carbon dioxide equivalent (CO_2e)-ton basis for the MAC methodology.

Appendix D provides estimates of the servicing demand for equipment affected by reclamation provisions contained in the final rule, by HFC gas.

Appendix E provides additional details on assumptions made in order to model requirements contained in the final rule on a dollar-per-CO_2e-ton basis for the MAC methodology and a summary of mitigation options modeled and estimated costs.

Appendix F provides results under an alternative reference case scenario in which industry is assumed to undertake more leak repair and recovery activity in the reference case (i.e., in the absence of this rulemaking), thus illustrating a lower bound of the potential incremental environmental impacts of this rule.

Appendix G provides a Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996 analysis of estimated impact to small entities, including small businesses and small governments, associated with establishing the leak repair and inspection provisions and ALD requirements to HFC and substitutes for HFCs.

Appendix H lists the industries that might be affected by this rule.

Appendix I provides a sensitivity analysis based on the assumed cost of reclaimed refrigerant vis a vis virgin refrigerant.

Appendix J provides a sensitivity analysis based on alternative ALD installation requirements considered for the final rule.

Appendix K provides additional details on the evaluation of potential costs and environmental impacts of the requirement that disposable cylinders that contain HFCs and that have been used in the service, repair or installation of refrigerant-containing equipment be sent to an EPA-certified reclaimer or another final processor in the supply chain, as well as sensitivity analyses related to these costs and environmental impacts.

2.3 Years of Analysis

This analysis estimates the costs and environmental impacts of compliance with provisions contained in the final rule. The earliest required compliance year is 2026, and—consistent with prior analyses conducted for the Allocation and 2023 Technology Transitions Rules—EPA has evaluated cumulative costs and environmental impacts through the year 2050. For the purposes of this analysis, we have assumed that full compliance will be reached for each provision contained in the final rule by the first year in which the requirement starts, and that compliance continues through 2050 (the final year included in this analysis).

2.4 Factors Analyzed

This TSD takes into consideration the compliance costs of meeting the requirements of this rule as finalized as well as the associated the environmental impacts of the consequent reduction in HFC emissions. Consistent with the Allocation Rules RIA and the 2023 Technology Transitions RIA Addendum, specific factors evaluated in this assessment include capital costs, operations and maintenance (O&M) costs, recordkeeping and reporting costs, anticipated refrigerant savings (e.g., from early leak detection and repair and heel recovery), and environmental impacts in terms of reductions in consumption and emissions of HFCs. This analysis does not consider certain factors that could potentially further reduce compliance costs, such as potential decreases in costs over time resulting from economies of scale or energy savings.

2.5 Vintaging Model

EPA uses the Vintaging Model to forecast the use and emissions of HFCs and other substances, by sector and subsector, under a business as usual (BAU) scenario and under various policy compliance scenarios. This analysis uses a version of the model intended to represent compliance with the AIM Act HFC Phasedown and 2023 Technology Transitions Rule as a starting point and makes adjustments to various subsectors of affected equipment and end uses as needed to align with the requirements of the final ER&R rule. The resulting consumption and emissions are compared against the analysis developed for the Allocation and 2023 Technology Transitions Rules to evaluate incremental impacts.

The model tracks the use and emissions of regulated substances separately for each generation or "vintage" of equipment. The Vintaging Model is used to produce the estimates of GHG emissions in the official U.S. GHG Inventory and is updated and enhanced annually. Information on the version of the model used for this analysis, the various assumptions used, and HFC emissions may be found in EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2014. A more detailed explanation of the Vintaging Model is also found in Section 3.2.1 of the Allocation Framework RIA.

2.6 Regulatory Option

The primary costs/benefits analysis conducted for this TSD is based on the estimated compliance costs and environmental impacts of the requirements contained in the final rule. In our analysis of the proposed rule, we investigated the potential costs and environmental impacts of alternative regulatory scenarios, including alternative equipment charge size threshold for the leak repair requirements. In this updated RIA Addendum for the final ER&R rule, EPA is providing additional costs and environmental impacts scenarios for alternative options considered for the final rule. These include:

- Alternative cutoff years for the final rule's ALD installation requirements for existing equipment, including scenarios where the requirements would have covered systems installed within 5 years of the compliance deadline or where the requirements would have covered all existing equipment (i.e., no cutoff date). See Appendix J for these results.
- Alternative compliance start years for the rule's provisions related to the management of disposable cylinders. See Appendix K for these results.

Importantly, the statutory direction for this final rule is not dependent on the analysis of costs and environmental impacts, but rather the rule is designed to serve the purposes identified in subsection (h) of the Act of "maximizing reclaiming and minimizing the release of a regulated substance from equipment and ensuring the safety of technicians and consumers." We refer the reader to the final rule for further explanation of the requirements finalized therein.

2.7 Uncertainty

Throughout this TSD, EPA has included a number of sensitivity analyses on particular modeling parameters and assumptions relied upon for this analysis. These include:

- Assumed cost of reclaimed HFCs vis-a-vis virgin manufactured HFCs (see Appendix I)

- Assumed industry behavior including improvements to leak repair and recovery that would occur in the reference case for this analysis (i.e., in the absence of this rulemaking) and resulting incremental environmental impacts (see Appendix F)
- The number of disposable refrigerant cylinders in circulation in the United States, the average volume of heel gas remaining in disposable cylinders, and the average rate of venting of heel gas versus removal (see Appendix K)

Chapter 3. Methodology

3.1 Reference Case and Relationship to Prior Analyses

Background

Through the Allocation Framework Rule (86 FR 55116, October 5, 2021) as well as an update to that rule, 2024 Allocation Rule (88 FR 46836, July 20, 2023), EPA has established a consumption baseline for the phasedown of HFCs.[8] The consumption baseline was established using the average annual quantity of all regulated substances consumed in the United States from January 1, 2011, through December 31, 2013, and additional quantities of past chlorofluorocarbon (CFC) and hydrochlorofluorocarbon (HCFC) consumption. More details on the methodology used to establish this baseline can be found in the Allocation Framework Rule.[9] The baseline serves as the starting point from which statutorily mandated percentage reductions are taken to implement the AIM Act HFC phasedown.

Following the finalization of these rules, EPA furthered the implementation of the AIM Act by finalizing the 2023 Technology Transitions Rule (88 FR 73098, October 24, 2023). The rule includes restrictions on the use of certain hydrofluorocarbons (HFCs) above a certain global warming potential (GWP) whether neat or used in a blend, and restrictions on certain HFCs and certain blends containing HFCs, in specific sectors or subsectors where HFCs are used.

EPA has previously estimated costs and environmental impacts of the HFC phasedown, which are detailed in the Allocation Framework RIA and 2024 Allocation Rule RIA Addendum, and for the 2023 Technology Transitions Rule, which are updated in the 2023 Technology Transitions Rule RIA Addendum. The final ER&R Rule focuses on statutory provisions under the AIM Act that are separate from those addressed in the Allocation Rules and 2023 Technology Transitions Rule. However, in order to avoid double counting or overestimating of costs and environmental impacts of this rule, for the purposes of this analysis the estimated economic and environmental impacts of these prior rules are assumed to be the status quo or "reference case"[10] from which incremental impacts may be calculated.

As detailed in the Allocation Framework Rule RIA, 2024 Allocation Rule RIA Addendum, and 2023 Technology Transitions Rule RIA Addendum, EPA relied upon a MACC approach in order to estimate the full set of industry transitions and associated compliance costs required to meet statutory

[8] The shorthand "Allocation Rules" is used throughout this document to refer to these rules together.

[9] https://www.federalregister.gov/documents/2021/10/05/2021-21030/phasedown-of-hydrofluorocarbons-establishing-the-allowance-allocation-and-trading-program-under-the.

[10] As a disambiguation, throughout this document we refer to the Allocation and 2023 Technology Transitions Rules estimates as the "reference case" rather than "baseline," to avoid confusion with the statutory baseline for the Allocation Rules.

requirements. Emissions reductions were estimated based on the difference between HFC emissions in the compliance pathway and HFC emissions under a BAU scenario without the statutory requirements in place. Analysis for this rule builds on this previously used methodology by adding on additional measures required by the final ER&R rule and evaluating their incremental impact.

HFC Consumption under BAU and Reference Case Projection

Under the previously modeled compliance pathways for the Allocation and 2023 Technology Transitions Rules, HFC consumption and emissions over time for appliances across all major sectors (including fire suppression, CC, IPR, and CR) are significantly lower (in CO2e terms) than they otherwise would be under a BAU scenario. Since this analysis assumes these transitions and improved service activities occur in the reference case, the estimated avoided emissions from some of the provisions contained in this final rule are less than what they would be if a BAU scenario were used that does not assume these transitions and improved service activities occur.

Table 3-1 below shows the consumption-based BAU originally used to quantify environmental impacts in the Allocation Rule analyses, as well as estimated consumption under the reference case used for this analysis that also incorporates impacts from the 2023 Technology Transitions Rule. The latter is used to quantify incremental environmental impacts in this analysis.

Table 3-1 – HFC Consumption under original BAU and reference case (MMTEVe)[11]

Year	***HFC Consumption under BAU (i.e., no AIM Act)***	***HFC Consumption under ER&R rule reference case (i.e., with Allocation and 2023 Technology Transitions Rules)***
2025	315	126
2030	317	60
2035	324	16
2040	337	27
2045	352	30
2050	366	33

[11] In this document, units for consumption and emission reductions are presented in Million Metric Tons Exchange Value Equivalent (MMTEVe) or Metric Tons Exchange Value Equivalent (MTEVe). As explained in the Allocation Framework Rule, a metric ton of exchange value equivalent (MTEVe) is numerically equal to a metric ton of carbon dioxide equivalent ($MTCO_2e$) and we use these terms interchangeably throughout this document.

Approach for Estimating Incremental Impacts

Results from this analysis indicate that the final ER&R rule will yield incremental HFC consumption and emissions reductions relative to the previously modeled compliance pathways.[12] However, the extent of these incremental environmental impacts depends in part on whether some of the HFC consumption- and emissions-reducing activities required by this final rule (such as improvements to detect and repair leaks) would have already been undertaken by industry in order to comply with, or otherwise address market outcomes from, the Allocation and 2023 Technology Transitions Rules.

As detailed in the 2023 Technology Transitions RIA Addendum, the precise set of transitions that will be undertaken by industry to meet compliance is uncertain, leading to a range in potential incremental environmental impacts. The 2023 Technology Transitions RIA Addendum included two primary compliance scenarios illustrating this uncertainty:

> a) a base case scenario where compliance options not explicitly required by the rule but envisioned under the Allocation Rules were excluded, thus yielding larger environmental impacts (i.e., greater reductions in HFC consumption and emissions) for certain subsectors but also smaller environmental impacts (i.e., lower reductions in HFC consumption and emissions) for other subsectors, relative to the Allocation Rule results.
>
> b) an upper-bound scenario of incremental environmental impacts where compliance options from the Allocation Rules were assumed to occur even though not explicitly required by the 2023 Technology Transitions Rule, including actions taken in the fire protection subsector, improved leak repair, and additional recovery at disposal.

To evaluate the incremental impacts of the ER&R rule relative to the policy status quo, the former, base case scenario from the 2023 Technology Transitions RIA Addendum is used as the primary reference case from which additional costs and environmental impacts are evaluated in this analysis. In this way, all measures found to be required to meet compliance with the Allocation and 2023 Technology Transitions Rules, based EPA's prior analyses, are assumed to occur in the reference case. Additional measures from the above-mentioned upper-bound scenario, which are not required to meet compliance with the Allocation and 2023 Technology Transitions rules (namely, enhanced recovery, leak repair, and transitions in the fire protection sector), are not assumed to occur in the reference case.

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[12] However, the schedule for the production and consumption phasedown is not made more stringent than the schedule under subsection (e)(2)(C) of the AIM Act (i.e., the production and consumption caps contained in the Allocation Rules are unchanged).

Given the uncertainty regarding whether industry may undertake these measures in the absence of explicit requirements, in Appendix F EPA has also provided an alternative scenario where we assume that the above-mentioned improvements to leak repair and recovery would occur even in the absence of this rule and they are therefore included in the reference case. This alternative scenario effectively illustrates a lower-bound of the incremental environmental impacts of the final ER&R rule.

EPA notes that the above assumptions are made for technical analytic purposes and to avoid double counting of environmental impacts. They should not be interpreted as a reflection of the merits of any particular provision contained in the final rule.

Moreover, there are likely additional significant benefits associated with provisions contained in the final rule that are not quantified in the incremental environmental impacts presented in this document. These include, but are not limited to:

- the life-cycle cost savings associated with the use of reclaimed HFCs and substitutes for HFCs as opposed to virgin HFCs and substitutes for HFCs;
- the moderation of future spikes in the cost of HFCs due to increased availability of reclaimed HFCs;
- avoidance of stranded equipment in later years when, if the market were reliant on virgin HFCs, equipment could be mothballed or prematurely retired due to HFC scarcity and shortages;
- the freeing up of available virgin HFCs for applications where reclaimed HFCs have not been proven effective for use; and
- avoided supply shortages of HFCs that are still needed for servicing certain appliances, by maximizing the supply of reclaimed refrigerant, thus protecting the cold chain needed to deliver food and vaccines.

3.2 Equipment Characterization

In order to evaluate costs and benefits, EPA relied on the Vintaging Model (described in section 2.5 above) to construct an inventory of equipment and appliances potentially affected by specific provisions contained in the final rule as well as associated use and disposition of regulated substances over time. This section provides a description of assumptions made to determine the universe of equipment and appliances affected. Qualitative descriptions of the broad categories of affected equipment and appliances are also provided.

Equipment in the Fire Suppression Sector

Fire suppression equipment covered by this final rule fall into two categories, and both types of equipment may contain HFCs that would be discharged in the event of a fire. Total flooding systems are designed to automatically discharge a fire extinguishing agent by detection and related controls (or manually by a system operator) and achieve a specified minimum agent concentration throughout a confined space (i.e., volume percent of the agent in air) that is sufficient to suppress development of a fire. Streaming applications use portable fire extinguishers that can be manually manipulated to discharge an agent in a specific direction and release a specific quantity of extinguishing agent at the fire. Table 3-2 summarizes reference case stock and emissions in 2025 for both end-uses within the Fire Suppression sector.

Table 3-2 – Estimated Installed Stock (MT) and Emissions (MT) by Equipment Type (2025)

Equipment Type	*Installed Stock (MT)*	*% of Total Installed Stock*	*Leak Emissions (MT)*	*% of Total Leak Emissions*
Total Flooding Systems	12,861	87%	322	83%
Streaming Units	1,872	13%	66	17%
Total	**14,733**		**387**	

Refrigeration and Comfort Cooling Appliances

A variety of Refrigeration, Air Conditioning, and Heat Pump (RACHP) appliances used in the United States contain refrigerants, and these appliances can be organized into charge size groups such as the following: 1) appliances containing five or fewer pounds of a refrigerant containing an HFC or substitute for an HFC, 2) appliances containing between five and 15 pounds of such refrigerant, and 3) appliances containing more than 15 pounds of such refrigerant. For this analysis, affected equipment is considered to be refrigeration and AC appliances containing 15 pounds or more of a refrigerant containing an HFC or substitute for an HFC with a GWP greater than 53.[13]

Figure 3-1 shows the projected installed stock of HFC refrigerant by RACHP appliance type across all equipment sizes in the United States in 2025, as modeled in EPA's Vintaging Model (EPA 2023f)[14]

[13] For brevity, unless otherwise stated, in this document we use the term "refrigerant" to include regulated HFCs and substitutes for HFCs with a GWP greater than 53.

[14] As explained in the RIA to the Allocation Framework Rule and associated addenda to that RIA, the Vintaging Model estimates the consumption and emissions from subsectors that traditionally relied on ODS and are transitioning to HFCs and other alternatives. The EPA 2023f version of the model (VM IO file_v4.4_02.04.16_Final TT Rule 2023 High Addition.xls) incorporates the transitions and practices anticipated to occur under the 2023 Technology Transitions RIA Addendum High Additionality Case, which in turn incorporates provisions of that rule and other actions anticipated under the 2024 Allocation Rule not otherwise adjusted based on the 2023 Technology Transitions Rule.

and Figure 3-2 shows estimated annual leak emissions (exclusive of loss during disposal) by appliance type in 2025. These appliances contain approximately 1.0 million MT (2.1 billion pounds) of HFC refrigerant and are estimated to release approximately 62,000 MT (140 million pounds) of HFC refrigerant in 2025 (an aggregate average leak rate of 6.2%) in the absence of control measures required by this rule. Table 3-3 summarizes stock and leak emissions in 2025 for each appliance type.

Figure 3-1 – Projected Installed Stock (MT) of HFC Refrigerant by RACHP Appliance Type and Charge Size (2025)

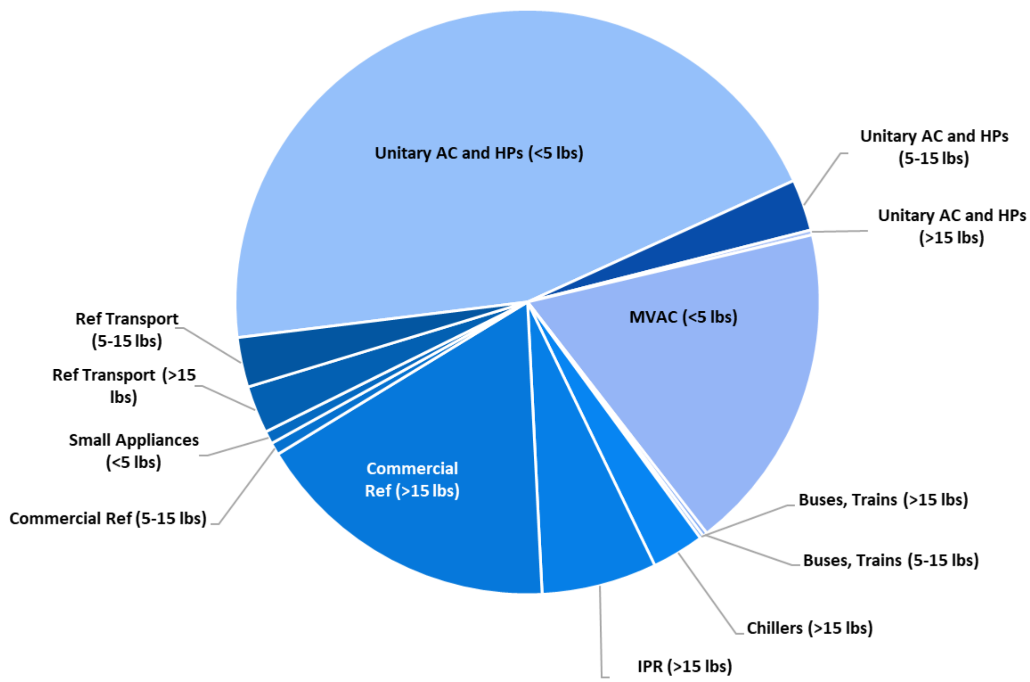


Figure 3-2 – Estimated Leak Emissions (MT) of HFC Refrigerant by RACHP Appliance Type and Charge Size (2025)

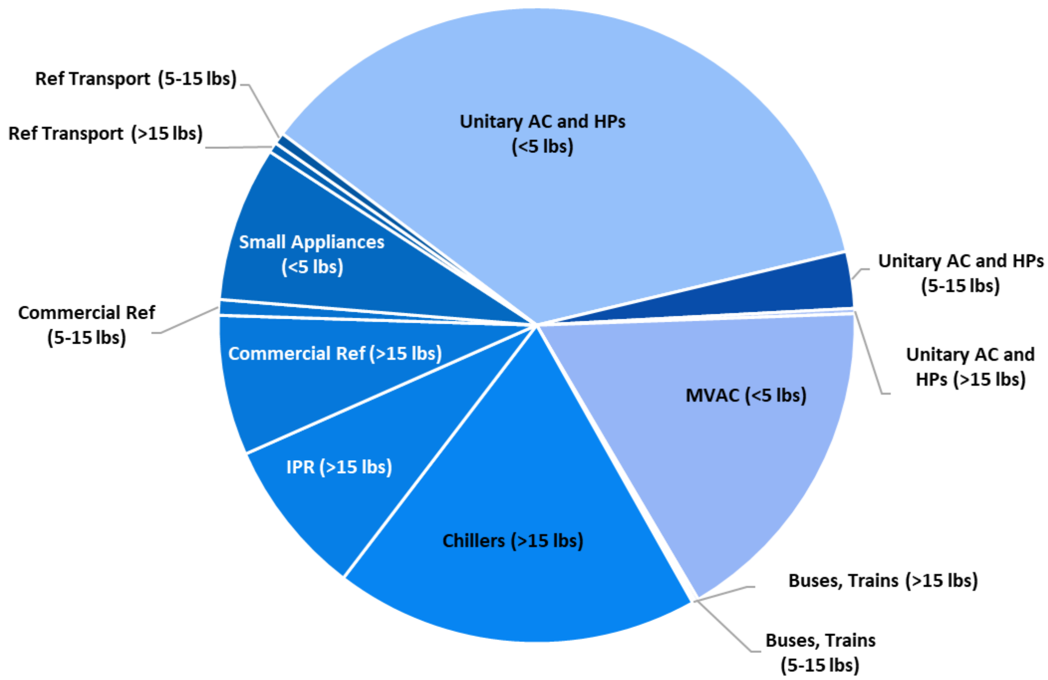


Table 3-3 – Estimated Installed Stock (MT) and Leak Emissions (MT) by Equipment Type (2025)

Equipment Type	***Installed Stock (MT)***	***% of Total Installed Stock***	***Leak Emissions (MT)***	***% of Total Leak Emissions***
MVAC (<5 lbs)	165,600	17%	11,300	18%
Unitary AC and HPs (<5 lbs)	348,400	36%	28,000	45%
Small Appliances (<5 lbs)	76,400	8%	400	0.6%
<5 lbs total	**590,400**		**39,700**	
Buses, Trains (5-15 lbs)	1,600	0.2%	200	0.3%
Ref Transport (5-15 lbs)	5,600	1%	1,700	3%
Commercial Ref (5-15 lbs)	7,700	1%	400	1%
Unitary AC and HPs (5-15 lbs)	27,900	3%	1,800	3%
5-15 lbs total	**42,800**		**4,100**	
Buses, Trains (>15 lbs)	1,500	0.2%	100	0.2%
Chillers (>15 lbs)	179,400	19%	1,800	3%
IPR (>15 lbs)	77,300	8%	3,900	6%
Commercial Ref (>15 lbs)	69,000	7%	10,600	17%
Ref Transport (>15 lbs)	5,000	1%	1,600	3%
Unitary AC and HPs (>15 lbs)	2,700	0.3%	200	0.3%

>15 lbs Total	**334,900**		**18,200**	
Total	**968,100**		**62,000**	

The ER&R rule covers three broad categories of RACHP appliances, which can be summarized as follows:

- **Commercial refrigeration (CR)** equipment are the refrigerant-containing appliances used in the retail food and cold storage warehouse sectors and refrigerated transport systems. Retail food appliances include the refrigeration equipment found in supermarkets, convenience stores, restaurants, and other food service establishments and include multiplex rack systems and condensing unit systems. Cold storage appliances include the equipment used to store meat, produce, dairy products, and other perishable goods. Refrigerated transport appliances include the equipment to move perishable goods (e.g., food) and pharmaceutical products by various modes of transportation, including rail and ships.
- **Industrial Process Refrigeration (IPR)** equipment are complex, customized refrigerant-containing appliances used in the chemical, pharmaceutical, petrochemical, and manufacturing industries. These appliances are directly linked to the industrial process. This sector also includes industrial ice machines, refrigerant-containing appliances used directly in the generation of electricity, and ice rinks.
- **Comfort Cooling (CC)** equipment includes stationary refrigerant-containing appliances that provide cooling in order to control temperature and/or humidity in occupied facilities, such as office buildings and commercial buildings, and mobile AC equipment. Comfort cooling appliances include building chillers (which can be further broken down by compressor type) and mobile AC for transit, school, and tour buses and passenger trains.

Additional description of the Vintaging Model end-uses within each sector and equipment category is provided in Appendix A.

Equipment Affected by Leak Repair and Inspection Provisions

The leak repair and inspection provisions contained in the final rule affect refrigerant-containing appliances with a charge size (i.e., amount of refrigerant in a given independent circuit) of 15 pounds or more. CR, CC, and IPR appliances containing 15 pounds or more of HFC refrigerant[15] were identified

[15] Although the final rule also covers substitutes for an HFC, this analysis focuses on HFCs and HFC-containing blends, including HFC-containing substitutes, noting that most other HFC substitutes modeled have small to zero GWPs (e.g., hydrocarbons, hydrofluoroolefins, carbon dioxide, and ammonia).

using EPA's Vintaging Model, which models equipment using average charge sizes. To provide additional variation in potential costs and environmental impacts for larger refrigerant-containing appliances where a more significant range of possible charge sizes is likely such that at least some portion of the appliances are addressed by this rule, end-uses were distributed into "low" (i.e., 50 percent of the modeled average charge size), "average" (i.e., the modeled average charge size), and "high" (i.e., 150 percent of the modeled average charge size) groups. Each group was assigned one-third of the total units, and the charge size distributions equal the weighted average charge size modeled in the Vintaging Model. Each end-use/charge size group was then categorized as sub-small (containing between 15 and 50 pounds of refrigerant), small (containing between 51 and 199 pounds of refrigerant), medium (containing between 200 and 1,999 pounds of refrigerant), and large (containing greater than 2,000 pounds of refrigerant). The categorization is done because provisions in the rule vary by charge size. Table 3-3 provides a mapping of end-uses into these three charge size groups and categorization. A more detailed version showing each end-use separately is available in Appendix A.

Table 3-4 – Apportionment of Appliance Types by Refrigerant Charge Size

Appliance Sector	***Appliance Type*** [a,b]	***Average Charge Size (lbs)*** [c]	***Distributed Charge Size Group***	***Charge Size Analyzed (lbs)***	***Equipment Size***
Comfort Cooling	School & Tour Bus AC	13	Low	5	N/A
			Average	11	N/A
			High	16	Sub-small
	Transit Bus AC	16	Low	8	N/A
			Average	16	Sub-small
			High	24	Sub-small
	Passenger Train AC	41	Low	20	Sub-small
			Average	41	Sub-small
			High	61	Small
	Chillers	1,105	Low	265 – 929	Medium
			Average	529 – 1,857	Medium
			High	794 – 2,786	Medium – Large
Commercial Refrigeration	Modern Rail Transport	17	Low	8	N/A
			Average	17	Sub-small
			High	25	Sub-small
	Vintage Rail Transport	33	Low	17	Sub-small
			Average	33	Sub-small
			High	50	Sub-small
	Condensing Unit	47	Low	23	Sub-small
			Average	47	Sub-small
			High	70	Small
	Marine Transport	1,021	Low	194 – 827	Small – Medium
			Average	388 – 1,653	Medium

			High	582 – 2,480	Medium – Large
	Rack	2,038	Low	1,019	Medium
			Average	2,038	Large
			High	3,057	Large
	Cold Storage	24,755	Low	12,110 – 12,716	Large
			Average	24,220 – 25,431	Large
			High	36,331 – 38,147	Large
Industrial Process Refrigeration	IPR	6,633	Low	972 – 7,939	Medium – Large
			Average	1,945 – 15,877	Medium – Large
			High	2,917 – 23,816	Large

[a] Only end-uses within appliance sectors CC, CR, and IPR are shown.
[b] End-uses with charge sizes less than 10 pounds are not shown as even under the "high" charge size group, they will not be affected by the leak inspection and repair provisions of the rule.
[c] For some appliance types, the Vintaging Model simulates multiple subsectors that are distinguished by size, original ozone-depleting substances (ODS) refrigerant type, or technology. In those cases, a range is provided.

Refrigerant-containing appliances with a charge size greater than or equal to 15 pounds must also exceed specified annual leak thresholds to trigger the leak repair and inspection requirements contained in the final rule, and CR and IPR appliances with refrigerant charge sizes of 1,500 pounds or more must use an ALD system.[16] The proportion of refrigerant-containing appliances above the applicable leak rate thresholds was based on appliance stock estimated in the Vintaging Model. Because the Vintaging Model models appliances using average leak rates,[17] appliance stock was distributed into quintiles, each containing 20 percent of units, where the leak rate distributions equal the weighted average leak rate modeled in the Vintaging Model for each appliance type. Based on this approach, it is assumed that each subsector has at least 20 percent of its stock (i.e., one quintile) above the threshold leak rate. By distributing leak rates in this way, we estimate the percentage of each end-use that leaks above the

[16] Owners and operators of refrigerant-containing appliances that are not required to install an ALD system (e.g., those with a charge size of less than 1,500 pounds) may voluntarily choose to install an ALD system as a compliance option for leak repair requirements in lieu of the applicable requirements for periodic leak inspections and certain recordkeeping and reporting requirements. However, leak inspections are required to be performed for the portions of the appliance where the ALD system is not monitoring for leaks.
[17] Under the base case scenario in this document, for chillers, large retail food (rack systems), cold storage, and industrial process refrigeration systems, the leak rate distributions were applied to the average leak rate modeled in the Vintaging Model as of 2026 with a 40 percent leak rate reduction, which is consistent with the assumption that larger refrigeration and AC equipment will experience enhanced leak recovery under the 2024 Allocation Rule as explained in the RIA to the Allocation Framework Rule and associated addenda to that RIA.

threshold rates under which actions are required by this rule.[18] As an example, Transit Bus AC has an average leak rate of 10% per year. We divide the end-use into five quintiles, with annual leak rates of 5%, 7.5%, 10%, 12.5%, and 15%. Therefore, we calculate that 40% of the appliances (those in the last two quintiles), exceed the threshold leak rate of 10% per year, See Appendix B for more detail.

Table 3-5 presents the assumptions made for this analysis regarding the proportion of affected refrigerant-containing appliances experiencing leaks above the threshold.

Table 3-5 – Affected Refrigerant-Containing Appliance Assumptions by Appliance Sector, Type, and Size

Appliance Sector	*Appliance Type*	*Appliance Size*	*Average Charge Size (lbs)[a]*	*Percentage of Appliances Experiencing Leaks Above the Threshold Rate*
Comfort Cooling	School & Tour Bus AC[b]	Sub-small	16	13%
	Transit Bus AC	Sub-small	16	40%
	Passenger Train AC	Sub-small	41	20%
	Chiller	Medium	265 – 1,985	20%
		Large	2,084 – 2,786	20%
Commercial Refrigeration	Modern Rail Transport[c]	Sub-small	17	80%
	Vintage Rail Transport[c]	Sub-small	33	80%
	Condensing Unit	Sub-small	47	20%
	Marine Transport	Small	194	80%
		Medium	388 – 1,653	60% – 80%
		Large	2,480	60%
	Rack	Medium	986–1,972	20%
		Large	2,959	20%
	Cold Storage	Large	10,655 – 38,147	20%
Industrial Process Refrigeration	IPR	Medium	1,049 – 1,059	20%
		Large	2,099 – 23,816	20%

[a] For some equipment types, the Vintaging Model models multiple subsectors which are distinguished by size, original ozone-depleting substances (ODS) refrigerant type, or technology. In those cases, a range is provided.
[b] 66 percent of School & Tour Bus AC units have charge sizes below the charge size threshold of 15 lbs. and therefore are not included as affected appliances (EPA 2023f).
[c] The Vintaging Model models two subsectors for refrigerated rail car transport: vintage and modern. Modern rail refrigeration systems are considered to be easily replaceable units previously developed for road transport and adapted for rail use, have a lifetime of approximately 9 years, and a refrigerant charge size less than 20 pounds. Older or vintage units were typically developed specifically for rail use and operate for the whole lifetime of the railcar itself (i.e., 40 years) and have larger charge sizes than modern systems (EPA 2023f).

[18] The threshold leak rates are the same as those established under 40 CFR, part 82, subpart F; namely, 30% per year for CR appliances, 20% per year for IPR appliances, and 10% per year for CC and all other refrigerant-containing appliances.

Equipment Affected by the Automatic Leak Detection Provisions

Refrigerant-containing appliances within the CC and IPR sectors are required to install an ALD system if the normal charge size is equal to 1,500 pounds or more. Some refrigerant-containing appliances are assumed to already have an ALD system installed. For instance, some refrigerant-containing appliances are provided with an ALD system, or have an option to include such. In this analysis, we assume 10 percent of affected refrigerant-containing appliances already have an ALD system installed in the reference case, and hence do not yield costs or benefits based on this rule.

In addition, the State of California requires the use of an ALD system if the refrigerant charge size exceeds 2,000 pounds. Using population as a proxy, we assume 12 percent of appliances with refrigerant charge sizes exceeding 2,000 pounds have an ALD system installed, in addition to the 10 percent reference case assumption. Combining these, and assuming a portion of the 10 percent reference case is in California, we estimate that 20.8 percent of appliances with refrigerant charge sizes over 2,000 pounds already have an ALD system installed.

For appliances between 1,500 and 2,000 pounds of refrigerant, we assume that an additional seven percent of affected appliances will already have an ALD system installed. This is the approximate percent of supermarkets represented under EPA's GreenChill voluntary program. As above, combining these two factors yields the assumption that 16.3 percent of affected appliances with refrigerant charge sizes between 1,500 and 2,000 pounds already have an ALD system installed.

Equipment Affected by Reclamation Provisions

The final ER&R rule also requires the use of reclaimed refrigerant to service and/or repair existing refrigerant-containing equipment in specific RACHP subsectors. Refrigerant-containing equipment in the supermarket systems, refrigerated transport, and automatic commercial ice makers subsectors must use reclaimed refrigerants containing HFCs when refrigerant containing HFCs is needed to service and/or the equipment. The universe of refrigerant-containing equipment affected by these provisions and corresponding refrigerant demand was estimated using EPA's Vintaging Model (EPA 2023f). In 2029 (the first compliance year for these provisions), accounting for the leak repair provisions in the final rule, total reclaimed refrigerant demand is estimated to be approximately 12,168 MT as shown in Table 3-6 below. Note that these totals only reflect the AIM-listed HFCs, including those that are incorporated in blends; for example, HFOs, whether neat or in a blend with HFCs, are not included because the requirement to use reclaimed refrigerants for service applies only to the regulated HFCs.

Appendix D provides additional, detailed tables showing estimated servicing demand by specific HFC gas for refrigerant-containing equipment affected by these provisions.

Table 3-6 – Service Demand of HFCs for Applicable RACHP Subsectors in 2029

Subsector	Refrigerant-Containing Equipment Type	Service Demand (MT)
Supermarket Systems		8,660
Refrigerated Transport	Road	1,405
	Vintage	10
	Modern Rail	9
	Intermodal Containers	304
	Marine	1,705
Automatic Commercial Ice Makers		75
Total		**12,168**

Reclamation of HFCs and refrigerants in general has been practiced for many years. While the required use of reclaim to service the above-listed subsectors may direct more reclaimed refrigerant thereto, it is likely that reclaimed refrigerants, to the extent available, will still be used in other subsectors. Recently reported total annual reclaim levels (3,450 MT in 2022) fall short of the above estimated demand for 2029, indicating that industry would have to make strides to increase reclamation totals in the coming years. This can be expected and has been seen in past refrigerant phaseouts. For instance, production of HCFC-22 for service ceased in 2020, yet numerous equipment continues to operate and continues to be serviced with reclaimed HCFC-22. Indeed, HCFC-22 has been the substance reclaimed the most (by mass) since at least the year 2000 (EPA, 2023e). To provide a perspective on recent reclaimed HFC levels, Table 3-7 below displays the amount of reclaim, in MT and million MT of CO_2e ($MMTCO_2e$), compared to consumption.

Table 3-7 – Summary of HFC reclaim and consumption

Year	Reclaimed HFCs (MT)[a]	Reclaimed HFCs ($MMTCO_2e$)[a]	Consumption ($MMTCO_2e$)[b]
2017	2,309	4.9	290
2018	2,382	5.1	306
2019	2,749	5.5	314
2020	2,445	5.0	309
2021	2,455	5.0	462
2022	3,450	7.2	253

[a] (EPA, 2024d)
[b] Years 2017-2021 from EPA's Greenhouse Gas Reporting Program (EPA, 2024b); 2022 from EPA's HFC Data Hub (EPA, 2024c).

These data indicate that there remains a wide gap between consumption of virgin regulated substances versus the amount that is reclaimed each year (a ratio of over 40 to 1 in 2022), and that significant increases in recovery and reclamation rates are possible. According to estimates from EPA's Vintaging Model, the amount of HFCs available for recovery at disposal (i.e., as equipment reaches the end of its useful life) in the coming years significantly exceeds the amount of demand from the subsectors required by the rule to use reclaimed refrigerant and shown in Table 3-6 above.

Reference case rates of recovery at disposal are derived from EPA's vintaging model BAU and correspond to equipment end-of-life loss rates of 5 to 65 percent of remaining refrigerant depending on equipment type.[19] At these rates, EPA estimates total annual recovery of HFCs from refrigerant-containing equipment of 35,458 MT in 2029, or almost three times the demand required by the final ER&R rule's servicing reclaim provisions, and well more than three times if 15 percent of the demand for reclaim shown above were met with virgin HFCs. Table 3-8 below provides assumed recovery and demand for HFCs estimated to be necessary to meet servicing requirements in 2029.

Table 3-8 – Modeled Recovery and Service Demand for HFCs in 2029 (RACHP only)

Gas	Estimated Reference Case Recovery in 2029 (MT)	Estimated Demand Resulting from ER&R Servicing Reclaim Provisions in 2029 (MT)	Estimated Demand Resulting from ER&R Servicing Reclaim Provisions in 2029 - 85% (MT)[a,b]
HFC-125	11,153	5,110	4,344
HFC-134a	13,376	3,381	2,874
HFC-143a	1,700	2,259	1,920
HFC-32	9,229	1,417	1,204

[a] Assumes 15% of reclaim demand will be met with virgin HFCs, consistent with regulatory requirements, thus reducing overall required demand for reclaimed HFCs.
[b] For blends, the assumed 15% reduction in demand shown in this table is applied proportionally across constituent HFCs. However, actual mix of virgin versus reclaimed of HFCs may vary. For example, a hypothetical 15/85 blend of HFC-143a and HFC-125 could comprise entirely virgin HFC-143a (a gas with shorter supply of estimated recovery in the above table), so long as the HFC-125 share (a gas with greater supply of estimated recovery in the above table) came entirely from reclaimed HFCs.

The values in Table 3-8 do not take into account industry's ability to leverage existing stocks and inventory of reclaimed material (provided they conform with the rule's requirement), which are likely to contribute to meeting the requirements of the rule, since reclaimed HFCs used to meet the requirements of the rule may have been recovered in prior years. In addition, the above values are inclusive of recovery and demand of specific blends, broken out by constituent HFCs. For example, a large share of the estimated recovery of HFC-125 and HFC-32 shown in Table 3-8 is driven by modeled recovery of R-

[19] The Vintaging Model assumes disposal recovery from equipment reaching end-of-life in a particular year is recovered and used, possibly after reclamation, to meet consumption demand for the same subsector and substance (i.e., new chemical demand plus servicing demand) in the same year.

410A (a 50/50 by weight blend of these two gases). These gases may then presumably be available to meet demand for blends such as R-452B (11% HFC-32 and 59% HFC-125), which drives a significant share of the estimated demand for these gases in Table 3-8. These dynamics may also indicate a need for continued industry capacity to reconstitute the component HFCs of recovered blends as demand changes in response to the 2023 Technology Transitions and ER&R Rules.

3.3 Marginal Abatement Cost Model

To generate cost estimates for the leak repair and inspection, fire suppression, and reclamation requirements of the final ER&R rule, EPA relied on a marginal abatement cost (MAC) methodology consistent with the approach used in the Allocation Framework RIA (see Section 3.2 of the Allocation Framework RIA) and the 2023 Technology Transitions RIA Addendum. As before, consumption- and emissions-reducing measures that meet compliance with the rule were modeled in terms of their costs on a dollars-per-ton of CO2e avoided basis and added to an integrated MAC curve of abatement measures required to meet compliance with existing regulatory requirements. The amount of regulated substance "available" to be avoided through measures required by the final rule was determined using EPA's Vintaging Model and refrigerant-containing equipment characterization assumptions detailed in section 3.2 above. Additional details on these assumptions as well as cost assumptions can be found in Appendices A, B, and C of this TSD.

The use of a MAC approach allows for consistency and comparability with EPA's prior results and for assessment of the costs of the final rule within the context of EPA's previously finalized regulations under the AIM Act. Similar to the approach taken for the 2023 Technology Transitions Rule, all abatement activities required to achieve compliance with the rule are assumed to occur in the compliance pathway. This differs from the approach originally used for the Allocation Framework Rule, which is agnostic in terms of the specific abatement measures that industry may take up in order to meet compliance with the statutory phasedown caps. Whereas for the Allocation Framework Rule a least-cost pathway was modeled which included only the level of abatement necessary to meet the statutory caps in each step-down year, the approach taken for the final ER&R rule as well as the 2023 Technology Transitions Rule assumes a specific compliance pathway informed by the sector-, subsector, and/or end-use-specific requirements of the rule.

Abatement Measures Modeled

This analysis uses the full set of required industry transitions previously modeled in the 2023 Technology Transitions Rule RIA addendum as the starting point from which potential incremental costs may be evaluated (i.e., the "base case" from the 2023 Technology Transitions RIA addendum). As discussed in the Allocation Framework Rule RIA, abatement measures can stem from a variety of compliance strategies, including reducing the amount of HFCs used in a piece of equipment (e.g., lowering charge sizes) and transitioning from using HFCs to alternatives such as hydrocarbons, ammonia, and hydrofluoroolefins (HFOs), which are not covered by the provisions of this rule as long as their GWP is 53 or lower, or HFC/HFO blends, which are covered by this rule as they contain an HFC. To model specific requirements from the final ER&R rule, EPA evaluated abatement measures falling into the following two general categories:

- Direct reduction in HFC losses from equipment (e.g., through leak repair)
- Use of reclaimed/recycled HFCs (e.g., to meet equipment servicing and/or repair or initial installation demand)

Table 3-9 below provides a summary of abatement measures modeled to evaluate the impact of specific ER&R rule requirements. For each abatement option modeled, total net costs associated with the strategy (e.g., leak detection costs minus any anticipated savings from reduce refrigerant consumption) are divided by the total amount of avoided HFC consumption to derive a cost estimate on a dollars-per-ton CO2e basis. Based on this approach, the average dollar-per-ton "break-even" cost tends to be lower for larger appliances or subsectors with large charge sizes, as opposed to smaller pieces of equipment where the amount of tons avoided per dollar is lower and hence the break-even cost is higher. For example, leak repair of large IPR systems has an estimated consumption abatement cost of approximately $1 per ton, whereas leak repair of medium IPR systems has an estimated consumption abatement cost of approximately $38 per ton.[20] Appendix E contains additional details on all abatement options developed and modeled for the final rule as well as their assumed break-even abatement costs in dollars per ton. Specific factors included in overall dollar-per-ton costs include equipment capital costs (e.g., ALD systems), labor costs (e.g., for conducting inspections and repairs), and savings associated with the avoided purchase of HFCs for servicing. For details on the bottom-up approach taken to estimate these factors for all affected equipment, including underlying data and assumptions used, see Appendix A.

[20] Unless stated elsewise, monetary figures are in 2022 U.S. dollars.

Table 3-9 – Summary of abatement measures modeled and key factors evaluated to derive MAC estimates

Type of abatement strategy modeled	*Corresponding ER&R Rule Requirements*	*Key Factors Evaluated to develop MAC abatement measure*
Direct reduction in HFC losses from equipment	• Leak detection and repair for appliances containing 15 lbs or more of refrigerant • Use of ALD systems for CR and IPR appliances containing 1,500 pounds or more of refrigerant • Minimize releases of HFCs during the servicing, repair, disposal, or installation of fire suppression equipment containing HFCs or during the use of such equipment for technician training	**Abatement:** avoided virgin HFC consumption required to meet servicing demand **Costs:** labor and equipment for conducting leak detection/ inspections and repairs; capital and O&M costs for ALD systems **Savings:** HFC savings associated with detecting and repairing refrigerant leaks earlier and avoiding refrigerant and fire suppression agent emissions
Use of reclaimed/ recycled HFCs	• Use of reclaimed refrigerant for servicing and/or repair of refrigerant-containing equipment for specific RACHP subsectors • Use of recycled HFCs for initial installation of fire suppression equipment • Use of recycled HFCs for servicing and/or repair of existing fire suppression equipment	**Abatement:** avoided virgin HFC consumption required to meet demand for initial installation or servicing **Costs:** cost of reclaimed/recycled HFCs vis a vis virgin manufactured HFCs **Savings:** avoided purchase of virgin HFCs

Table 3-10 below shows which provisions of the final rule were modeled to apply to which end-uses within the RACHP sector, and which charge size groups of those end-uses.

Table 3-10 – Applicability of Requirements by Appliance Sector and Equipment Type

Sector	*Equipment Type*	*Distributed Charge Size Group*	*Average Charge Size (lbs)*	*Provision (Start Date)*		
				Leak Inspection &Repair (2026)	*Use of ALD (2026/2027)*[a]	*Reclaimed Refrigerant Servicing (2029)*
Comfort Cooling	School & Tour Bus AC	Low	11			
		Average				
		High		√		
	Transit Bus AC	Low	16			
		Average		√		
		High		√		
		Low	41	√		

Sector	*Equipment Type*	*Distributed Charge Size Group*	*Average Charge Size (lbs)*	*Provision (Start Date)*		
				Leak Inspection &Repair (2026)	*Use of ALD (2026/2027)*[a]	*Reclaimed Refrigerant Servicing (2029)*
	Passenger Train AC	Average		√		
		High		√		
	CFC-11 Centrifugal Chillers	Low	1,504	√		
		Average		√	√	
		High		√	√	
	CFC-12 Centrifugal Chillers	Low	1,566	√		
		Average		√	√	
		High		√	√	
	R-500 Chillers	Low	2,012	√		
		Average		√	√	
		High		√	√	
	CFC-114 Chillers	Low	1,389	√		
		Average		√		
		High		√	√	
	Screw Chillers	Low	661	√		
		Average		√		
		High		√		
	Scroll Chillers	Low	529	√		
		Average		√		
		High		√		
	Reciprocating Chillers	Low	529	√		
		Average		√		
		High		√		
Commercial Refrigeration	Modern Rail Transport	Low	17			√
		Average		√		√
		High		√		√
	Vintage Rail Transport	Low	33	√		√
		Average		√		√
		High		√		√
	Condensing Unit	Low	47	√		
		Average		√		
		High		√		
	Road Transport[b]	Low	10			√
		Average				√
		High				√
	Intermodal Containers[b]	Low	10			√
		Average				√
		High				√
	Reefer Ships	Low	1,653	√		√
		Average		√	√	√
		High		√	√	√
		Low	388	√		√
		Average		√		√

Sector	***Equipment Type***	***Distributed Charge Size Group***	***Average Charge Size (lbs)***	***Provision (Start Date)***		
				Leak Inspection &Repair (2026)	***Use of ALD (2026/2027)[a]***	***Reclaimed Refrigerant Servicing (2029)***
	Merchant Fishing Transport	High		√		√
	CFC-12 Large Retail Food (supermarkets)	Low	2,038	√		√
		Average		√	√	√
		High		√	√	√
	R-502 Large Retail Food (supermarkets)	Low	2,038	√		√
		Average		√	√	√
		High		√	√	√
	CFC-12 Cold Storage	Low	25,431	√	√	
		Average		√	√	
		High		√	√	
	HCFC-22 Cold Storage	Low	24,220	√	√	
		Average		√	√	
		High		√	√	
	R-502 Cold Storage	Low	24,613	√	√	
		Average		√	√	
		High		√	√	
	Ice Makers[b]	Low	6			√
		Average				√
		High				√
Industrial Process Refrigeration	CFC-11 IPR	Low	1,945	√		
		Average		√	√	
		High		√	√	
	CFC-12 IPR	Low	2,078	√		
		Average		√	√	
		High		√	√	
	HCFC-22 IPR	Low	15,877	√	√	
		Average		√	√	
		High		√	√	

[a] Where required, refrigerant-containing appliances that were installed on or after January 1, 2017, and before January 1, 2026, must include an ALD system as of January 1, 2027. Refrigerant-containing appliances installed on or after January 1, 2026 must include an ALD system upon installation or within 30 days of installation of the refrigerant-containing appliance.
[b] Road Transport and Intermodal Containers average charge sizes are less than 10 pounds but shown as rounded values. Therefore, these appliance types (even under the "High" distributed charge size group) along with Ice Makers are not affected by the leak repair or ALD provisions but are affected by the reclaim provisions.

Model limitations and assumptions regarding the impact of reclaim requirements

The EPA Vintaging Model estimates HFC consumption and the resulting emissions without explicitly defining the mix of virgin vs. reclaimed or recycled gases that is used by end use category. Certain assumptions were necessary to determine the reduction in consumption and emissions attributable to reclamation activity as: (1) the ER&R rule provisions pertaining to reclaimed HFCs allow for reclaimed HFCs to be mixed with up to 15 percent virgin HFCs; and (2) some reclamation activity would be expected to occur in the absence of this rule. To account for these factors, the modeled change in consumption for options requiring reclaimed HFCs is scaled to remove the proportion not attributable to the rule. Thus, for a particular measure requiring reclaim, the change in consumption is determined as,

$$\Delta C_r = \Delta C_0(1-(p_b+p_v))$$

where $\boldsymbol{\Delta C_0}$ is the initially calculated change in consumption from the Vintaging Model (e.g., total demand for a given end use to be met using reclaimed HFCs), $\boldsymbol{p_b}$ is the proportion attributable to reclamation already assumed in the reference case, and $\boldsymbol{p_v}$ is the proportion coming from virgin HFCs (assumed to be 15%, i.e., the maximum share allowable).

Specific approaches for determining consumption and emission reductions resulting from ER&R rule abatement measures are summarized as follows:

- For measures in which the required use of recovered/reclaimed HFCs was modeled:
    - Consistent with the above formula, EPA first factored out share of demand already met by recovery and reclamation activity assumed in the reference case[21], and the 15% maximum share of virgin HFCs that may be included in "reclaimed" refrigerant per regulatory definitions was also factored out.
    - EPA conservatively assumed that the measure would not result in an additional reduction in emissions beyond the emissions reductions from recovery of HFCs and avoided venting at disposal and servicing already included in the reference case.
- For measures in which a direct reduction in HFC losses from equipment was modeled (e.g., due to leak repair or ALD requirements), and the affected equipment category was not covered by a use of reclaim for servicing requirement, it was assumed the servicing demand would have been met using virgin HFCs. A reduction in consumption of virgin HFCs equivalent to total avoided emissions was assumed.
- For measures in which a direct reduction in HFC losses from equipment was modeled (e.g., due to leak repair or ALD requirements), and the affected equipment category was also covered by a use of reclaim for servicing requirement, it was assumed the servicing demand would have been met through reclaimed HFCs. The full emission reduction associated with the leak repair activity

[21] A reference case share of demand met by recovery and reclamation of 26.5% was used, derived from the Vintaging Model BAU. For more details, see Appendix E.

was assumed. EPA then used the above methodology to convert from emissions reductions to consumption reductions attributable to the rule.

For more details on these and other specific assumptions applied to the abatement measures modeled for this rule, see Appendix E.

Updated MAC Compliance Path

The leak repair, automatic leak detection, fire suppression, and use of reclaim provisions modeled as abatement measures each have a net cost or savings estimated per ton of CO2 equivalent consumption or emissions avoided. To evaluate the incremental cost of these provisions relative to EPA's previous analysis, these options were integrated with the set of MAC options previously assumed to achieve compliance with the Allocation and 2023 Technology Transitions Rules. The result is an updated compliance path which combines ER&R Rule provisions' measures with those previously modeled.

For reference, Figure 3-3 below shows the consumption MAC curves associated with the Allocation Rules and 2023 Technology Transitions Rule compliance path. These curves illustrate all compliance measures modeled to be achieved as result of implementation of these rules, with each point representing the dollar-per-ton cost associated with abatement at a given threshold when moving (left-to-right) from lowest-to-highest cost measures. The compliance path for these previous rules is the reference case for this analysis, and is shown for 2026 (the first compliance year for the ER&R rule) and 2036 (the final step-down year under the Allocation Rules). These curves illustrate all measures assumed in the compliance path in each year from lowest-cost to highest-cost, with total consumption abatement reaching approximately 242.3 MMT CO2e in 2026 and 323.1 MMT CO2e in 2036.

Figure 3-3 – Marginal Abatement Cost Curves in 2026 and 2036 – Allocation and 2023 Technology Transitions Rule Reference Case

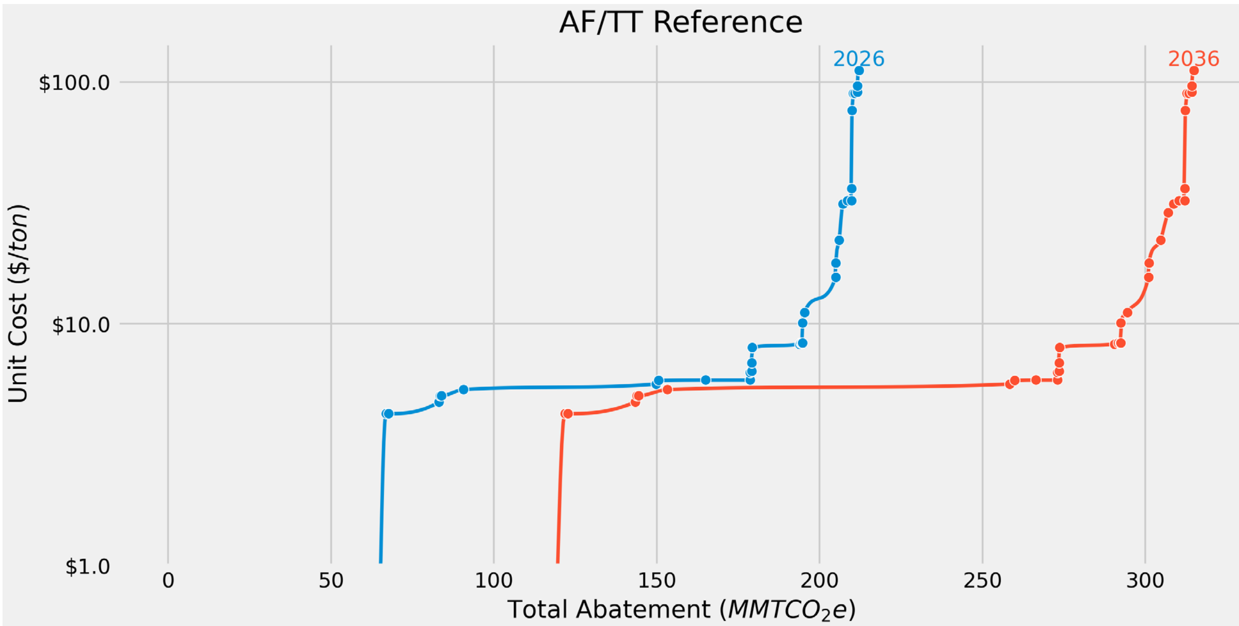
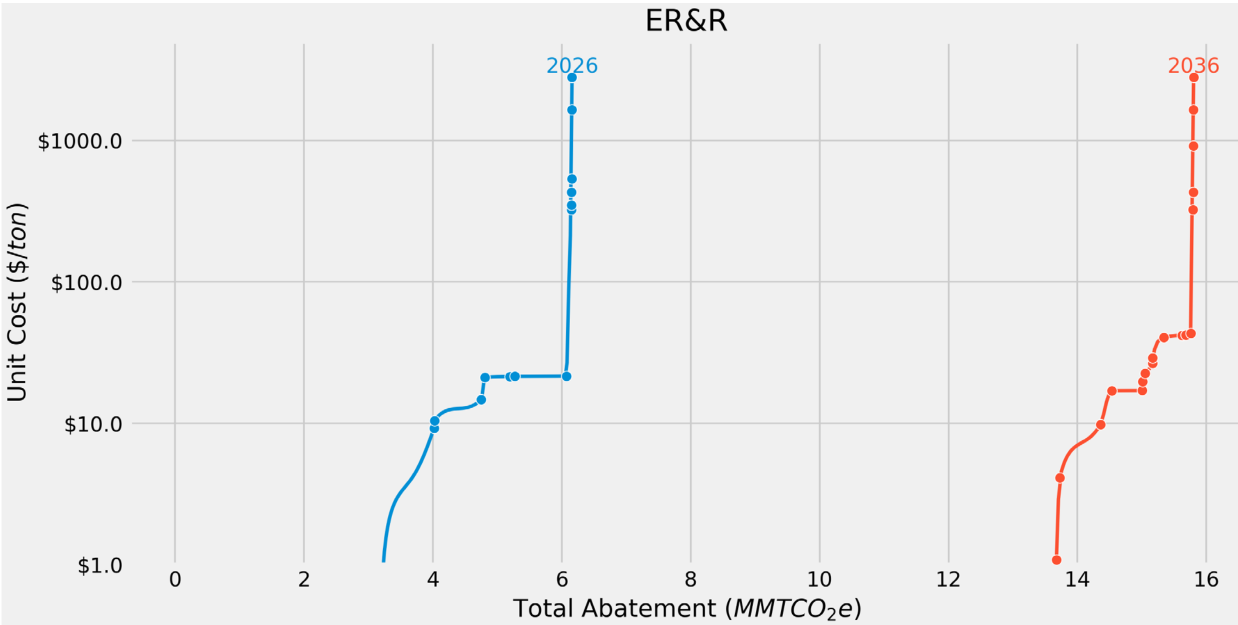


Figure 3-4 below then shows the additional abatement measures modeled for the final ER&R Rule described in the preceding sections. As shown, consumption abatement from these measures reaches an additional approximately 3.7 MMT CO2e in 2026 and 7.3 MMT CO2e in 2036.

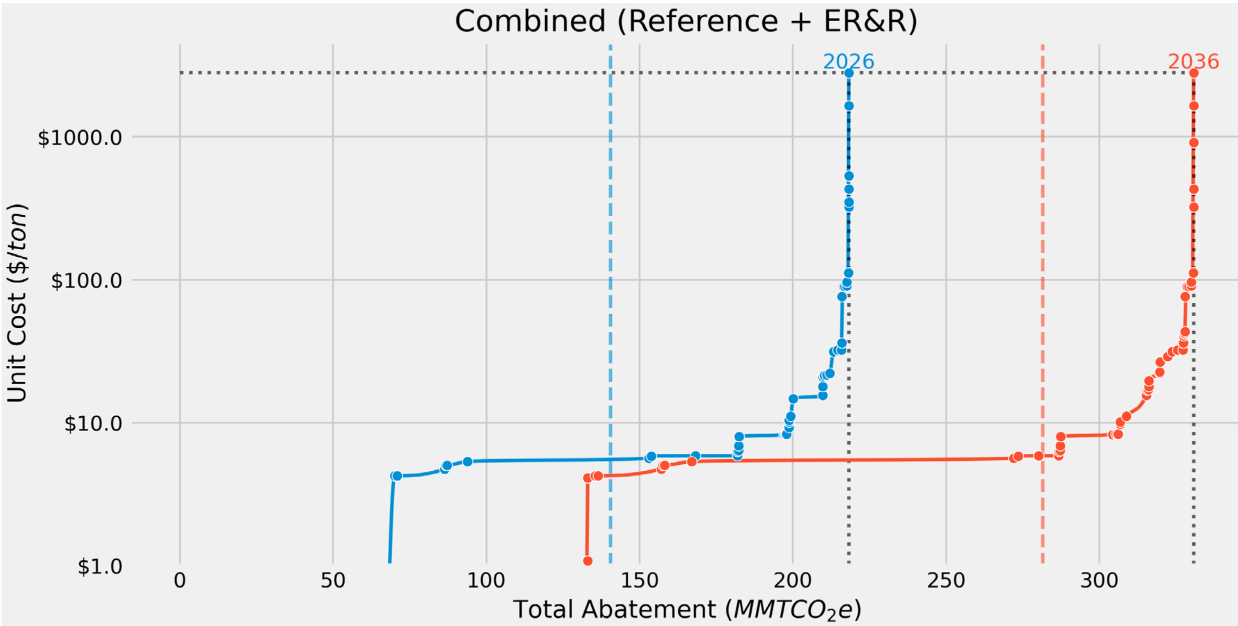
Figure 3-4 – Marginal Abatement Cost Curves in 2026 and 2036 – Additional ER&R Rule Measures



Finally, Figure 3-5 below shows the integrated MAC curves reflecting both the reference case compliance measures assumed for the Allocation and 2023 Technology Transitions Rules as well as the updated measures evaluated for the final ER&R Rule. These curves illustrate total abatement assumed and assumed costs-per-abatement measure for the full suite of existing AIM Act regulations including the final ER&R Rule. A dashed vertical line showing the total amount of abatement required by the Allocation Rule (i.e., the abatement necessary to meet the HFC phasedown steps) in 2026 (blue) and 2036 (red) is provided for reference.[22]

[22] However, the schedule for the production and consumption phasedown is not made more stringent than the schedule under subsection (e)(2)(C) of the AIM Act (i.e., the production and consumption caps contained in the Allocation Rules are unchanged).

Figure 3-5 – Revised Integrated Cost Curves in 2026 and 2036 –Allocation and 2023 Technology Transitions Rules with additional ER&R Rule measures



3.4 Other Costs from Rule Requirements

Certain requirements contained in the final rule were not modeled using a MACC approach described above, either because they do not directly impact HFC consumption and emissions or because they relate to HFC consumption and emissions sources that are exogenous to the Vintaging Model. For these measures, separate approaches were used to evaluate compliance costs and avoided consumption and/or emissions of HFCs, as detailed below. These measures include:

- Requirements pertaining to the management of disposable cylinders of refrigerants and fire suppressants
- Alternative Resource Conservation and Recovery Act (RCRA) standards for ignitable spent refrigerants being recycled for reuse
- Recordkeeping and reporting requirements

Disposable cylinder management requirements

The provisions of this Rule include requirements to remove the heel from used disposable cylinders before the cylinders are discarded; the requirement covers disposable cylinders used for servicing, repair, disposal, or installation of refrigerant-containing appliances. For analytical purposes, the Agency focused on anticipated additional reductions in HFC consumption and emissions as well as industry costs and the potential savings from avoided refrigerant loss.

To assess the impact of these provisions, EPA relied in part on the report, *Refrigerant Cylinders: Updated Analysis of Use, Disposal, and Distribution of Refrigerants* (EPA 2024a), analyzing the costs and environmental impacts of the requirement that disposable cylinders that have been used for the servicing, repair, or installation of refrigerant-containing equipment be transported to an EPA-certified reclaimer or another final processor within the supply and disposal chain (e.g., a distributor, repackager, wholesaler, landfill operator, or scrap metal recycler), and that these entities remove all HFCs (i.e., heel) from disposable cylinders prior to discarding the cylinder. If the heel is removed by a final processor or otherwise in the supply and disposal chain, the removed heels may be consolidated, but must be sent to an EPA-certified reclaimer or a fire suppressant recycler.

The report assesses the typical distribution of refrigerants in cylinders, including refrigerant changes expected under the Base Case; i.e., the scenario incorporating the 2023 Technology Transitions Rule. Based on the wide range of disposal practices currently employed and expected to continue in absence of this final rule, three scenarios were developed to estimate the emissions avoided: a low scenario (i.e., a lower heel left in the cylinder), a central scenario, and a high scenario.

The emissions avoided by removing such heels are dependent on the number of disposable cylinders in circulation and the average heel that would otherwise be emitted, and hence not available for reclaim, in absence of this rule. Based on the report cited above, we assume in the central scenario that there are approximately 4.5 million cylinders in circulation, of which 99 percent are disposable. Further, we estimate that the average heel is approximately 4 percent by weight of the nominal capacity (e.g., 0.96 pounds for a 24-pound cylinder).[23] Because of the other regulations in place, it is expected that the average GWP of the refrigerant in such cylinders will decrease. Other emissions associated with cylinders—for example, during transport and storage—are not expected to change based on this rule.

To account for the costs associated with the change in procedure handling of cylinders (i.e., returning the cylinders for heels to be removed) we analyze possible ways a cylinder might travel before the heel is removed and the truly-empty cylinder is landfilled or recycled. This analysis assumes that some cylinders will be: (a) sent directly to the reclaimer; (b) returned to a wholesaler or distributor, who will ship disposable cylinders to a landfill or steel recycling facility, which would combine heels for shipment to a reclaimer; and (c) shipped directly from the end-user or technician to a landfill or steel recyling facility,

[23] R-404A is typically sold in a 24-pound cylinder. Cylinders for other HFC refrigerants are typically larger, from 25 to 50 pounds. We use 24 pounds as a conservative estimate here.

which would combine heels for shipment to a reclaimer. For paths (b) and (c) above, we assume the landfill or steel recycling facility would reduce costs by combining 25 refrigerant heels (at 0.96 pounds as discussed above) of each HFC or blend containing an HFC (e.g., HFC/HFO blends) they receive into individual 24-pound cylinders before sending those to a reclaimer. After recovering heels, reclaimers are assumed to send disposable cylinders to a landfill or steel recycler.

Neat HFOs, which are not regulated substances under this rulemaking but are used in some RACHP equipment, are not accounted for in the analysis. For HFCs and blends containing an HFC, we divide cylinders equally amongst the transportation paths described above. Thus, we assume one-third follow path (a), one-third follow path (b), and one-third follow path (c). Table 3-11 displays the estimated mileage for each leg of the paths taken compared to the business-as-usual (BAU) route.

Table 3-11 – Estimated Distances for Disposable Cylinder Transportation Compared with BAU (Miles)[a]

Transportation Leg	*BAU*	*(a) End-user to Reclaimer to Landfill*	*(b) End-user to Distributor to Reclaimer*	*(c) End-user to Landfill*
Producer/Filler to Wholesale Distributor	1,000	1,000	1,000	1,000
Wholesale Distributor to End User/Technician	25	25	25	25
End User/Technician to Steel Recycler/Landfill	75	NA	NA	75
End User/Technician to Reclaimer	NA	50	NA	NA
End User/Technician to Wholesale Distributor	NA	NA	25	NA
Distributor or Reclaimer to Steel Recycler/Landfill	NA	75	75	NA
Landfill sending Recovered Refrigerant to Reclaimer[b]	NA	NA	75	75
Total Miles per Cylinder	**1,100**	**1,150**	**1,128**	**1,103**

[a] CARB (2011)
[b] Each cylinder sent represents 25 cylinders received with heels.

The additional travel costs are influenced by how many cylinders fit on a truck, the fuel to drive the extra distances, and the incremental labor for such. By removing heels that would have otherwise been emitted and hence not available for reclaim, an additional supply is provided that would offset virgin production providing additional savings based on the cost of refrigerant. These assumptions are shown in Table 3-12 below.

Table 3-12 – Additional Disposable Cylinder Cost Assumptions

Factor (units)	*Value*	*Source*	*Notes*
Cylinders per Truck	1,120	CARB (2011)	
Average Truck Speed (miles per hour)	50	CARB (2011)	

Truck Transport Labor Rate ($/hour)	$53.59	U.S. Bureau of Labor Statistics (2023b)	May 2022 mean, including 110% overhead
Average Fuel Consumption (miles per gallon)	6.1	Geotab (2017)	Average across all states
Fuel cost ($/gallon)	$4.034	EIA (2024)	Price of diesel as of March 25, 2024
Cost of HFC refrigerant ($/pound)	$4		Consistent with past AIM Act analyses

Accounting for the fuel and labor associated with the additional shipment of cylinders and the cost of refrigerants, we estimate costs and benefits, and hence the net benefits, and environmental impacts, as shown in Section 4.2 below and Appendix K.

Further details on the costs, benefits, and environmental impacts of the cylinder management requirements and a sensitivity analysis around some of the assumptions above are provided in Appendix K.

RCRA alternative standards

The final rule includes alternative RCRA (Resource Conservation and Recovery Act) standards for ignitable spent refrigerant. The purpose of these alternative standards is to help reduce emissions of ignitable spent refrigerants to the lowest achievable level by maximizing the recapture and safe reclamation/recycling of such refrigerants during the maintenance, service, repair, and disposal of refrigerant-containing appliances. The estimated compliance costs and savings resulting from these alternative standards are provided in this TSD for informational purposes. However, because they fall under a separate statutory authority from the AIM Act, they are not directly incorporated into the overall compliance costs and environmental impacts estimates associated with this rulemaking and presented elsewhere in this document.

These alternative standards may incentivize additional reclamation of ignitable spent refrigerant over disposal, although EPA has not assumed they will result in additional recovery and reclamation consumption and emissions reductions beyond those already accounted for in response to other provisions contained in the final ER&R rule. The alternative standards also are expected to result in an overall reduction in compliance costs for management of ignitable spent refrigerant under RCRA. Avoided costs include reduced transportation costs (hazardous waste manifest and transporter not required under the alternative standards), avoided compliance costs of complying with hazardous waste generator regulations for appliance owners and technicians, and avoided hazardous waste incineration costs for recovered ignitable spent refrigerant. Offsetting these avoided costs would be the cost to reclaimers for meeting the new standards for emergency preparedness and response, and for documenting that the ignitable spent refrigerant is not speculatively accumulated.

These cost estimates are heavily dependent on the future market for ignitable spent refrigerant sent for reclamation, which is difficult to predict with currently available data. In addition, because the alternative RCRA standards are voluntary, and regulated entities can always choose to disposed of ignitable spent refrigerant under the full RCRA standards if that is the economically preferred option, EPA anticipates that the RCRA alternative standards would either be economically neutral or result in an overall cost savings.

Reporting and Recordkeeping Requirements

The final rule includes provisions that are expected to result in additional recordkeeping and reporting costs for owners and operators of refrigerant-containing appliances related to leak repair and inspection. Additional recordkeeping and reporting costs are also anticipated for the requirement to include a certification that reclaimed refrigerant contains no more than 15 percent virgin HFC. For owners and operators of fire suppression systems, and entities that employ technicians who install or maintain fire suppression systems, additional reporting and recordkeeping requirements apply. All recordkeeping and reporting costs are calculated by multiplying the estimated burden (hours) times the average annual respondent hourly cost (labor plus overhead).

In deriving these costs, EPA identified applicable standard occupational classifications for each respondent and used the corresponding 2022 mean hourly rate from the Bureau of Labor Statistics (BLS 2023a). The resulting costs outlined in Table 3-13 are the average hourly administrative cost of labor plus overhead for private firms (assumed to be 110 percent).

Table 3-13 – Labor Rates

Respondent	***Bureau of Labor Statistics Information***			***Total***
	Standard Occupational Classification	***Occupational Title***	***Mean Wage***	
Technicians	49-9021	Heating, Air-Conditioning, and Refrigeration Mechanics and Installers	$27.63	**$58.02**
Owners/ Operators	17-2111	Health and Safety Engineers	$49.79	**$104.56**

A brief summary of the specific approaches and assumptions applied for all relevant recordkeeping and reporting requirements is provided below.

Requests for extensions to the leak repair and retrofit timelines

Owners or operators of CC, CR, and IPR appliances normally containing 15 or more pounds of HFC refrigerant can apply to EPA for an extension to the leak repair and appliance retrofit timeframe. The total number of extension requests for CC, CR, and IPR HFC equipment was estimated by scaling the number of extension requests estimated for Ozone Depleting Substance (ODS)-containing equipment in the supporting ICR 1626.18[24] based on the proportion of total HFC equipment to ODS equipment modeled in EPA's Vintaging Model (EPA 2023f).

Installation records

Consistent with the ICR, this analysis assumes 1.5 minutes of burden time each time a refrigerant-containing appliance is installed. Vintaging Model assumptions described in section 3.2 were used to identify the pool of affected appliances (i.e., new appliances with refrigerant charge sizes at or above 15 pounds) (EPA 2023f).

Purchase and service records

Consistent with the ICR, this analysis assumes 1.5 minutes of burden time each time a refrigerant-containing appliance that contains an HFC or a substitute for an HFC with a GWP greater than 53 is serviced.[25] Vintaging Model assumptions described in section 3.2 were used to identify the pool of affected appliances (i.e., all appliances with refrigerant charge sizes at or above 15 pounds) and the expected number of times that the affected appliances would be serviced. The total number of servicing events is assumed to be equal to the number of times that service technicians provide invoices (i.e., one time per year for all refrigerant-containing appliances with charge sizes at or above 15 pounds) (EPA 2023f).

Results of verification tests

The final rule includes leak repair regulations that require initial and follow-up verification tests on repairs made after the leak rate threshold is exceeded for a refrigerant-containing appliance. EPA's Vintaging Model was used to identify the affected pool of appliances (as described in section 3.2). For every occurrence of a refrigerant-containing appliance exceeding the applicable leak rate threshold, 1.5 minutes of burden time was assumed to maintain reports on the results of verification tests (EPA 2023f).

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[24] ICR 1626.18 was developed to estimate burden associated with reporting and recordkeeping of leak repair and inspection requirements for appliances containing more than 50 pounds of ODS refrigerant.

[25] This assumption is premised on service technicians already needing to record information on services for invoicing, so the only incremental burden is in saving the data to a record file. For the significant percentage of service companies that record service information digitally in apps or other software, no additional time is needed to save logged data.

Leak inspections

The final rule requires that covered CR and IPR appliances with a refrigerant charge size less than 500 pounds or CC and other appliances with a refrigerant charge size of at least 15 pounds conduct a leak inspection once per calendar year until the owner or operator can demonstrate through leak detection calculations that the refrigerant-containing appliance has not leaked in excess of the applicable leak rate for one year. CR and IPR appliances with a refrigerant charge size from 500 pounds up to 1,500 pounds would be required to conduct a leak inspection quarterly (i.e., once per three-month period). Appliances, or portions of appliances, continuously monitored with an ALD system that is certified annually, including appliances with a refrigerant charge size of 1,500 or more pounds, would not be required to conduct an annual leak inspection. This analysis assumes that the recordkeeping time associated with maintaining leak inspection records is one minute. EPA's Vintaging Model was used to identify the affected pool of appliances (as described in section 3.2) (EPA 2023f).

Plans to retrofit appliances

The final rule requires that owners or operators of IPR, CC, and CR appliances normally containing 15 or more pounds of a refrigerant must develop and maintain a plan to retire or retrofit the appliance in the following cases after the applicable leak rate is exceeded: an owner or operator chooses to retrofit or retire rather than repair a leak, an owner or operator fails to take action to repair or identify a leak, or a refrigerant-containing appliance continues to leak above the applicable leak threshold after a repair attempt was made. The total number of retrofit requests for CC, CR, and IPR appliances containing 15 or more pounds of a refrigerant was estimated as 1 percent of all affected appliances leaking above the threshold (see section 3.2). For each retrofit plan, 8 hours of burden time was assumed.

Reports on systems that leak 125 percent or more

EPA is requiring owners/operators of refrigerant-containing appliances subject to the leak repair and inspection provisions to prepare and submit reports describing efforts to identify and repair leaks for appliances that leak 125 percent or more of the full charge in a calendar year. Using the assumptions in the ICR for ODS equipment and scaling proportionately based on the ratio of affected ODS and HFC appliances, this analysis estimates that approximately 417 appliances have an annual leak rate greater than 125 percent. For each refrigerant-containing appliance meeting or exceeding this leak rate threshold, 1 hour of burden time was assumed to prepare and submit a report for each occurrence.

Requests to cease a retrofit

The final rule allows owners/operators of appliances containing 15 or more pounds of refrigerant to submit a request to cease a retrofit if certain requirements are met, including an agreement to repair all identified leaks within one year of the retrofit plan's date. To estimate the costs for this reporting requirement, it was assumed that 5 percent of those that develop a retrofit plan will submit a request to cease their retrofit. Each request is assumed to take 30 minutes to complete.

Annual calibration of ALD system

The final rule requires owners/operators of refrigerant-containing appliances using ALD systems to maintain records regarding the annual calibration or audit of the ALD system. Records must be maintained each time an ALD system detects a leak, whether that be based on the applicable ppm threshold for a direct ALD system or the indicated loss of refrigerant measured in the ALD system. EPA assumes indirect ALD systems will collect and store this directly and no burden is assumed. For owners/operators of direct ALD systems, 1 minute of burden time is assumed.

Labeling of reclaimed material with no more than 15% virgin material

It was assumed that reclaimers already label material and, therefore, will only need to modify labels to indicate the batch contains no more than 15% virgin material. The label modification was assumed to require 9 hours of both graphic design and administrative work.

Fire Suppression requirements

The final rule requires recordkeeping and reporting in the Fire Suppression sector. Those who first fill a fire suppression equipment with a regulated substance must report annually on the amount of such substances based on what is sold, recovered, recycled or virgin material and likewise on material sent for disposal. In addition, fire suppression technician employers must maintain records regarding the training used and documentation that the training was provided. Owners and operators of fire suppression equipment must also maintain records documenting that the regulated substances were recovered prior to sending the equipment for disposal. All records must be maintained for three years. EPA estimates that it will take 9.4 hours annually for the reporting, and an additional 40 hours annually for recordkeeping, per entity. We assume there will be 20 entities that will be required to perform the recordkeeping and reporting, including 15 reporters that already collect and share information under the voluntary HFC Emissions Estimating Program (HEEP).

3.5 Other Potential Benefits of this Rule

The estimated environmental benefits of this rule that are quantified and presented in this analysis are the benefits of avoiding GHG emissions that would contribute to climate damages. There are, however, additional potential benefits that would follow from the provisions, some of which that are not quantified in this analysis.

The provisions that require leak inspections, the repair of leaks, and/or the installation of ALD systems for certain refrigerant-containing appliances are best practices for the maintenance and upkeep of such appliances. Following such best practices accrues benefits for the owner/operator of the appliance by reducing the loss of refrigerant, resulting in savings that are estimated in this analysis. Many unquantified benefits from such best practices also exist. A regular practice of inspecting refrigerant-containing appliances and repairing leaks when detected (rather than topping-up the appliance) also prevents such appliances from breaking down as often and can prolong the effective service life of the appliances.[26] Fewer repairs of broken appliances and extending their service life directly benefits owner/operators, and in the case of refrigerant-containing appliances, reducing operation failures has the additional benefit of reducing the loss of refrigerated stock.[27] The costs of a refrigerant-containing appliance at a retail store failing and thousands of pounds of perishable stock being lost are considerable, and the aggregate costs of such food waste to the U.S. economy are also significant. In 2021, approximately 344,000 MT of food were lost due to refrigerant-containing equipment issues in the retail and food service sectors, with a value of $1.87 billion.[28]

The provisions of this rule designed to maximize reclaim would provide a number of additional benefits that are not quantified. As the HFC phasedown progresses, the supply of virgin HFCs will be reduced, but the demand for refrigerants, fire suppression agents, aerosol propellants, etc. may continue to grow. When complying with restrictions set by the 2023 Technology Transitions Rule, many uses of HFCs are expected to transition to using lower-GWP—and in some cases non-HFC—substitutes, but it is expected that demand for HFCs will continue, in part based on historic experience with the ODS phaseout. For example, although halons have not been produced or imported into the United States for decades, recycled halons are still used for the initial installation and servicing of certain fire suppression equipment. Reclaimed and recycled HFCs will be needed to meet the continuing demand and to meet certain requirements in the Rule.

By avoiding supply shortages of HFCs that are still needed for servicing certain appliances, maximizing reclaim avoids the economic disruption that might occur, including the stranding of equipment. A robust supply of reclaimed refrigerant would also protect the cold chain needed to deliver food and vaccines. Maximizing reclaim would also benefit sectors not directly covered by provisions of this rule, including certain specialized uses that cannot use reclaimed HFCs.

[26] Crippa, 2021; Barnish, 1997
[27] Brush, 2011
[28] ReFED 2020

Chapter 4. Compliance Costs

Using the methodological approaches described chapter 3 of this TSD, EPA has estimated the compliance costs associated with the provisions contained in the final ER&R Rule. Compliance costs also include all estimated savings (e.g., savings associated with avoided purchase of virgin refrigerant) and may therefore be net negative in certain cases.

The sections below summarize the estimated compliance costs for all relevant provisions contained in the final rule.

4.1 Leak repair and inspection, reclamation, and fire suppression requirements

As described in chapter 3, compliance costs for the leak repair and inspection, reclamation, and fire suppression requirements contained in the final rule were estimated using a marginal abatement cost (MAC) modeling approach. The additional HFC consumption- and emissions-reducing measures required by the final rule and their associated costs were estimated on a cost-per-ton of CO2e basis and integrated with the broader set of abatement measures previously assumed in the compliance path for the Allocation and 2023 Technology Transitions Rules. Results of the base case scenario from the 2023 Technology Transitions Rule RIA Addendum were used as the status quo from which the incremental costs stemming from the additional ER&R measures were evaluated.

Table 4-1 below shows the estimated incremental costs for a subset of model years included in the analysis by provision type.

Table 4-1 – Incremental Annual Compliance Costs of MAC Abatement Measures (Millions 2022$)

Year	Leak Repair/ALD	Use of Reclaim for Servicing	Fire Suppression Requirements
2026	$79.5	$-	$0.2
2030	$88.3	$3.9	$0.8
2035	$75.0	$3.1	$0.9
2040	$57.5	$2.3	$0.9
2045	$43.4	$1.8	$1.0
2050	$43.3	$1.9	$1.0

The cost curves below illustrate an updated, integrated compliance path that includes the abatement measures assumed in for the Allocation and 2023 Technology Transitions Rules compliance pathway along with the additional abatement measures required by the ER&R rule. The curves present rolling total compliance costs and U.S. HFC consumption in a given year as abatement measures are applied from lowest- to highest-cost measures (left to right). The curves help to show the relationship between total abatement and costs. Notably, and as illustrated in Table 4-1 above, for certain ER&R measures such as leak repair annual abatement and costs decreases over time as HFCs in remaining stocks of equipment reduces. By contrast, abatement and costs (or savings) for the previously modeled 2023 Technology Transitions Rule build over time as the market penetration of HFC alternatives builds over time. The curves represent all options assumed to be undertaken to meet compliance, so the rightmost data point shows the resulting abatement and total cost in a given year (i.e., the rightmost points represent final abatement and net costs in each year after all required measures are applied).

Figure 4-1 – Integrated Annual Abatement Pathways under AIM Rules

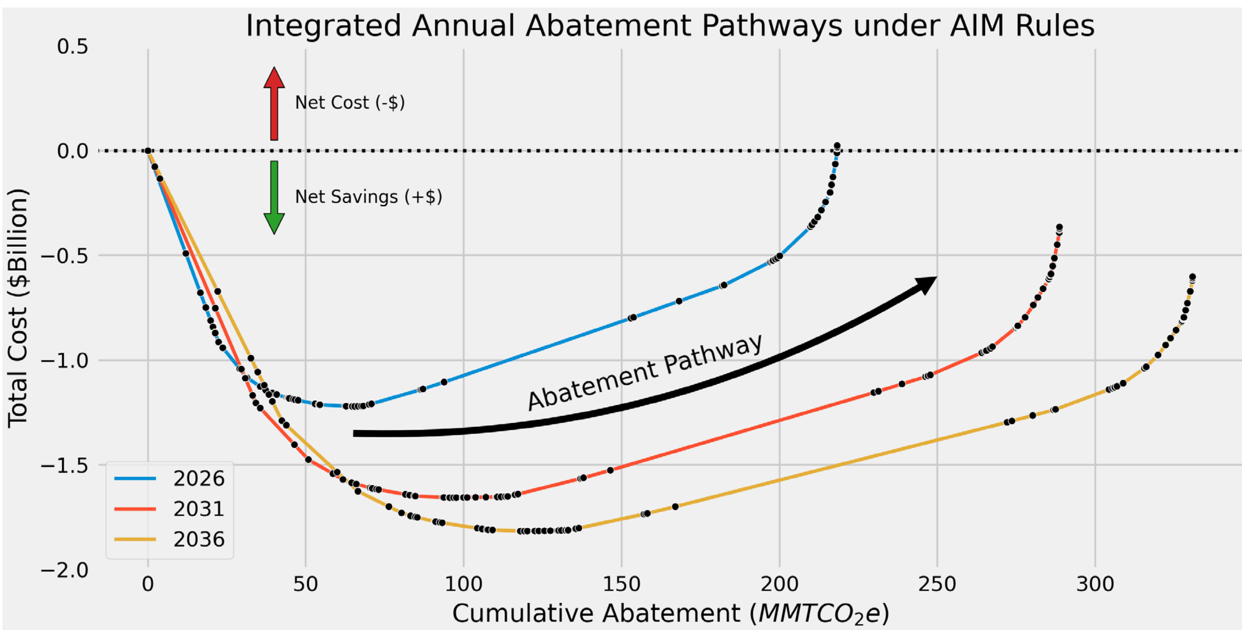

Figure Description: The curves above start with total costs incurred with the cheapest (or most cost-effective) abatement measures applied, with more expensive options added as the curve moves left to right. Points to the left of the low point on each curve represent measures with assumed net negative costs (or cost savings), while points to the right of the low point on each curve represent measures with assumed net positive costs. The rightmost point on each curve for a given year in each figure represents the final total net cost with all required abatement options being applied.

4.2 Disposable cylinder management requirements

To assess the impact of these provisions, EPA relied in part on the report, *Refrigerant Cylinders: Updated Analysis of Use, Disposal, and Distribution of Refrigerants* (EPA 2024a). The report assesses the cost implications for the requirement for heel removal, accounting for the costs associated with the change in procedure handling of cylinders (e.g., transporting the cylinders for heel removal prior to discarding the cylinder) and the potential savings from avoided refrigerant loss from heel emissions. Because neat HFOs, CO_2, ammonia, and hydrocarbons are not regulated substances, these costs and environmental impacts do not reflect possible handling of those refrigerants. For the cylinders containing HFCs (and blends containing HFCs), this analysis assumes that one third will be returned directly to a reclaimer, another third will be returned to a distributor, and the other third will be shipped directly to a landfill or scrap recycling center.

Table 4-2 below summarizes the estimated net costs of these requirements for a subset of model years from 2025-2050. Further detail including sensitivity analyses around some of the assumptions may be found in Appendix M.

Table 4-2 – Estimated Compliance Costs for Cylinder Management Provisions (Millions 2022$)

Year	Transportation Costs	Refrigerant Savings	Net Costs
2028	$0.14	$12.9	-$12.8
2030	$0.14	$12.6	-$12.4
2035	$0.13	$11.7	-$11.6
2040	$0.12	$11.3	-$11.2
2045	$0.12	$11.1	-$10.9
2050	$0.12	$11.0	-$10.9

4.3 RCRA alternative standards

As described in Chapter 3, the amendments to RCRA standards for reclaimers are anticipated to be cost neutral or to provide some savings from reduced compliance burden on these entities. As documented in the ICR (ICR Number 2778.01), the average annual reduction in compliance burden is approximately $2,131,844. Taking this value as the net reduction in compliance costs of the amendments for each year from 2026 (the first year in which the avoided costs are estimated to accrue) through 2050 and discounting the savings to 2024, the present value of the savings would be $22.7 million (7 percent discount rate), $35 million (3 percent), or $40 million (2 percent). As discussed in Chapter 3, due to uncertainty and the voluntary nature of the alternative standards, the net savings may be lower and are shown in this document as a range from $0 to the discounted values above. In addition, these standards fall under a separate statutory authority from the AIM Act and are therefore not incorporated into the overall compliance costs and environmental impacts estimates associated with this rulemaking presented elsewhere in this document.

4.4 Recordkeeping and reporting requirements

The final ER&R rule contains several provisions that EPA has estimated will result in additional recordkeeping and reporting cost burden for affected industries. EPA has prepared an information collection request (ICR), ICR Number 2778.01, and a Supporting Statement which can be found in the docket.[29] The information collection requirements for recordkeeping, reporting, and labeling are not enforceable until OMB approves them. Among other things, EPA calculated the estimated time and financial burden over a three-year period (ICRs generally cover three-year time periods) for respondents to implement labeling practices and to electronically report data to the Agency on an annual basis. A summary of the respondent burden estimates follows. A summary of underlying assumptions and methods used can be found in section 3.4 of this document, and the full methodology for these calculations can be found in the docket.

For the three years covered in the ICR, the total respondent burden associated with information collection will average 4.8 million hours per year and the respondent cost will average $19.2 million per year. The breakdown of the burden per year is provided in Table 4-3 in 2022 dollars. The ICR will be subject to renewal after the three-year time period is over.

Table 4-3 – Total Respondent Burden Costs Over the Three-year ICR Period (2022$s)

Year	***Total Responses***	***Total Hours***	***Total Labor Costs (2022$)***	***Total O&M Costs (2022$)***	***Total Costs (2022$)***
Year 1 (2026)	4,445,381	141,372	$12,155,355.28	$0.00	$12,155,355
Year 2 (2027)	4,810,033	223,029	$17,580,430.39	$0.00	$17,580,430
Year 3 (2028)	5,115,220	396,447	$27,869,424.28	$0.00	$27,869,424
3yr ICR Annual Average	4,790,211	253,616	$19,201,736.65	$0.00	$19,201,737

[29] Docket ID: EPA-HQ-OAR-2022-0606

Chapter 5. Environmental Impacts

5.1 Consumption and Emission Reductions

EPA's Vintaging Model is used to estimate both consumption and emissions for each regulated substance for each generation or "vintage" of equipment in both a reference case scenario and policy compliance scenario. Reductions in consumption (in units of MMTEVe) are calculated for a given year by summing the total tons of virgin manufacture of HFCs avoided resulting from compliance with the rule across all end-uses. Emission reductions are similarly calculated by summing total HFC emissions avoided across end-uses in the compliance scenario. For many of the requirements contained in the final ER&R rule, emissions reductions are assumed to occur in the same year as corresponding reductions in consumption and vice versa. For example, leak repair and inspection measures result in avoided emissions from equipment leaks and an equivalent amount of avoided demand (i.e., consumption) that would otherwise be required to "top off" the leaking equipment. In this case, both the emissions reduction and equivalent consumption reduction are modeled as occurring in the same year. As another example, measures that require increased recovery of HFCs from equipment at disposal also yield a reduction in emissions (since it is assumed the gas would otherwise be released), however the timing of when this recovered material will be then be placed back onto the market as reclaimed refrigerant is uncertain and may well occur well after the material was recovered.

The reference case for this analysis includes baseline levels of recovery of HFCs and resulting avoided emissions, derived from the Vintaging Model BAU. While the requirements pertaining to use of reclaimed HFCs contained in the final rule may yield further recovery of HFCs and resulting avoided emissions, EPA has conservatively assumed that these measures do not necessarily yield incremental HFC emissions reductions beyond these baseline levels.[30] EPA has further assumed that not all reclaimed HFCs utilized for the servicing and/or repair of certain refrigerant-containing equipment would be in direct response to this rule, and that some reclamation would occur in the absence of policy. In this way, EPA has conservatively estimated the amount of HFC recovery, re-use, and reclamation activity attributable to the rule's provisions versus the amount that would otherwise occur in the absence of the

[30] This assumption is made for technical analytic purposes and to avoid over-estimation of incremental benefits relative to the established model BAU relied upon for previous analyses including the Allocation Rules and 2023 Technology Transitions Rule RIA and RIA Addenda, and should not be interpreted as a reflection of the merits of any particular provision contained in the final rule.

requirements. More details on these assumptions can be found in Chapter 3 as well as the appendices accompanying this document.

Due to these factors and assumptions, in the results presented below consumption and emission reductions resulting from the measures included in this analysis may not occur on a one-to-one basis in a given year and may also be less than the full amount of refrigerant demand affected by a particular provision. For more details on these assumptions, please see section 3.3 and Appendix E of this TSD.

Table 5-1 below shows the consumption reductions by year corresponding to the final ER&R Rule compliance scenario (base case) evaluated in this analysis. As discussed in Chapter 3 of this document, incremental environmental impacts reflect reductions that are additional to the compliance scenario previously assessed by EPA in the 2023 Technology Transitions Rule RIA Addendum.

Table 5-1 – Annual Incremental Consumption Reductions (MMTCO$_2$e) for ER&R Rule – Base Case Scenario

Year	Leak Repair and ALD	Fire Suppression	Use of Reclaim (Servicing)	Cylinder Management
2026	5.4	0.77	0.0	0.0
2030	4.7	4.1	12	2.1
2035	3.9	4.3	8.4	1.5
2040	2.6	4.5	5.7	1.1
2045	1.3	4.7	4.4	0.94
2050	0.68	4.9	4.5	0.90
Total (2026-2050)	**78**	**98**	**151**	**31**

Table 5-2 below shows the emissions reductions by year corresponding to the final ER&R Rule compliance scenario (base case) evaluated in this analysis. As discussed in Chapter 3 of this document, incremental environmental impacts reflect reductions that are additional to the compliance scenario previously assessed by EPA in the 2023 Technology Transitions Rule RIA addendum.

Table 5-2 – Annual Incremental Emissions Reductions (MMTCO$_2$e) for ER&R Rule – Base Case Scenario

Year	Leak Repair and ALD	Fire Suppression	Use of Reclaim (Servicing)	Cylinder Management
2026	5.4	0.01	-*	0.0

2030	5.6	0.01	-	2.1
2035	4.6	0.01	-	1.5
2040	3.0	0.01	-	1.1
2045	1.5	0.01	-	0.94
2050	0.92	0.01	-	0.90
Total (2026-2050)	**88**	**0.21**	**-**	**31**

*Reclaim requirements may lead to additional emissions reductions by inducing increased recovery of refrigerant at servicing and disposal that may otherwise be released or vented. In our base case scenario, EPA does not estimate an increase in these avoided emissions beyond reference case assumptions.

The mix and distribution of HFCs in refrigerant-containing appliances is anticipated to change significantly in the coming decades, resulting in different leak repair and inspection environmental impacts for later years. As shown in Table 5-2 above, the annual GWP-weighted GHG emissions avoided from HFC refrigerants resulting from leak repair and ALD provisions in 2050 is less than half that of 2026. This is not due to decreased efficacy of leak repair or ALD systems or a decrease in use of refrigerant, but rather is a result of the reduction over time in the average GWP of the refrigerant contained in equipment that would otherwise leak.

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Appendices

Appendix A. Underlying Data and Assumptions used to Estimate Costs and Environmental impacts for Leak Repair and Inspection Provisions

The sections below describe the method and assumptions used to estimate aggregate incremental costs and environmental impacts associated with the Agency's final regulations related to leak repair and inspection.

Refrigerant-Containing Equipment Mapping

To develop the scope of appliances affected by the leak inspection and repair requirements of the final rule, EPA utilizes the Vintaging Model. As explained in section 3.2, we divide each end-use within the model into three (low, average, and high) to estimate a range of charge sizes across any single end-use because the model only provides an average charge size. From that distribution, we determine appliance types that are not affected by the leak repair and inspection provisions of the final rule (charge size less than 15 pounds) and divide those that are affected into four groups: sub-small (15 to 50 pound charge size); small (51 to 199 pound charge size); medium (200 to 1,999 pound charge size); and large (2,000 pounds or greater charge size). This mapping for CC, CR, and IPR end-uses is shown in Table A-1.

*Table A-**Error! Bookmark not defined.** – Apportionment of Appliance Types by Charge Size*

Appliance Sector	*Appliance Type* [a,b]	*Average Charge Size (lbs)*	*Distributed Charge Size Group*	*Charge Size Analyzed (lbs)*	*Equipment Size*
Comfort Cooling	School & Tour Bus AC	11	Low	5	N/A
			Average	11	N/A
			High	16	Sub-small
	Transit Bus AC	16	Low	8	N/A
			Average	16	Sub-small
			High	24	Sub-small
	Passenger Train AC	41	Low	20	Sub-small
			Average	41	Sub-small
			High	61	Small

	CFC-11 Centrifugal Chillers	1,504	Low	752	Medium
			Average	1,504	Medium
			High	2,255	Large
	CFC-12 Centrifugal Chillers	1,566	Low	783	Medium
			Average	1,566	Medium
			High	2,439	Large
	R-500 Chillers	2,012	Low	1,006	Medium
			Average	2,012	Large
			High	3,018	Large
	CFC-114 Chillers	1,389	Low	695	Medium
			Average	1,389	Medium
			High	2,084	Large
	Screw Chillers	661	Low	331	Medium
			Average	661	Medium
			High	992	Medium
	Scroll Chillers	529	Low	265	Medium
			Average	529	Medium
			High	794	Medium
	Reciprocating Chillers	529	Low	265	Medium
			Average	529	Medium
			High	794	Medium
Commercial Refrigeration	Ice Makers[c]	6	Low	3	N/A
			Average	6	N/A
			High	8	N/A
	Modern Rail Transport	17	Low	8	N/A
			Average	17	Sub-small
			High	25	Sub-small
	Vintage Rail Transport	33	Low	17	Sub-small
			Average	33	Sub-small
			High	50	Sub-small
	Road Transport[c]	10	Low	5	N/A
			Average	10	N/A
			High	15	N/A
	Intermodal Containers[c]	10	Low	5	N/A
			Average	10	N/A
			High	15	N/A
	Condensing Unit	47	Low	23	Sub-small
			Average	47	Sub-small
			High	70	Small
	Reefer Ships	1,653	Low	827	Medium

			Average	1,653	Medium
			High	2,480	Large
	Merchant Fishing Transport	388	Low	194	Small
			Average	388	Medium
			High	582	Medium
	CFC-12 Large Retail Food	2,038	Low	1,019	Medium
			Average	2,038	Large
			High	3,057	Large
	R-502 Large Retail Food	2,038	Low	1,019	Medium
			Average	2,038	Large
			High	3,057	Large
	CFC-12 Cold Storage	25,431	Low	12,716	Large
			Average	25,431	Large
			High	38,147	Large
	HCFC-22 Cold Storage	24,220	Low	12,110	Large
			Average	24,220	Large
			High	36,331	Large
	R-502 Cold Storage	24,613	Low	12,306	Large
			Average	24,613	Large
			High	36,919	Large
Industrial Process Refrigeration	CFC-11 Industrial Process Refrigeration	1,945	Low	972	Medium
			Average	1,945	Medium
			High	2,917	Large
	CFC-12 Industrial Process Refrigeration	2,078	Low	1,039	Medium
			Average	2,078	Large
			High	3,117	Large
	HCFC-22 Industrial Process Refrigeration	15,877	Low	7,939	Large
			Average	15,877	Large
			High	23,816	Large

[a] Only end-uses within appliance sectors CC, CR, and IPR are shown.
[b] End-uses with charge sizes less than 10 pounds are not shown as even under the "high" charge size group, they will not be affected by the leak inspection and repair provisions of the rule.
[c]Road Transport and Intermodal Containers average charge sizes are less than 10 pounds but shown as rounded values. Therefore, these appliance types along with Ice Makers are not affected by the leak repair or ALD provisions but are affected by the reclaim provisions.

Cost assumptions

The rule provisions associated with leak repair and inspection are expected to result in:

- **Incremental compliance costs** associated with conducting leak detection/inspections and repairs.

- **Refrigerant savings** associated with detecting and repairing leaks earlier.

Costs and savings were first estimated using a model equipment approach, and then were scaled up industry-wide based on the total number of affected refrigerant-containing appliances using EPA's Vintaging Model (EPA 2023f).

Leak Repair

The final regulation results in incremental compliance costs to owners and operators when leaks in appliances containing 15 or more pounds of refrigerant containing an HFC or a substitute for an HFC that has a GWP above 53 exceed the threshold leak rate. Owners and operators must repair leaks within 30 days, or, under certain circumstances, request an extension to conduct the repair. If leaks cannot be repaired, the appliance must be retrofitted or retired. These requirements are incremental for owners and operators of appliances containing 15 or more pounds of such refrigerant that exceeds the leak rate of 10 percent for CC, 20 percent for CR, or 30 percent for IPR equipment. When leaks are repaired, all appliances must also conduct initial and follow-up verification tests.

Leak repair outcomes. Extending leak rate thresholds to these refrigerant-containing appliances should result in leaks being identified and repaired sooner than previously assumed in the Allocation Rule Reference Case previously evaluated by EPA. This analysis assumes that leaks will be detected and repaired earlier across all CC, CR, and IPR appliances containing 15 pounds or more of HFC refrigerant. Specifically, the analysis assumed that HFC appliances that experience a leak event requiring repair realizes one of three outcomes:

- The **standard repair** outcome conservatively assumes that as a result of the leak rate threshold, repairs are conducted six weeks earlier than they would have been conducted when waiting for the system performance to noticeably change due to refrigerant loss. If the system is using ALD monitoring, repairs are assumed to be conducted ten weeks earlier.
- Under the **extension repair** outcome, owners/operators request an extension for conducting the repair. The analysis conservatively assumes that repairs are also conducted six weeks earlier as a result of the leak repair requirements (or ten weeks earlier if the system is using ALD monitoring). As mentioned above, the extension allows owners/operators additional time to repair an appliance if components cannot be delivered within the necessary time.
- The **retrofit** outcome assumes that systems that require retrofitting are retrofitted 5 years earlier than they would have been in the absence of the final regulations (i.e., five years were assumed to be remaining before normal end-of-life).

Table A-2 Below shows the proportion of affected appliances assumed to experience each outcome.

Table A-1 – Leak Repair Outcomes and Proportions

Outcome	***HFC Systems***
Standard Repair	98%
Extension Repair	1%
Retrofit	1%

Frequency of repair. Data reported under California's Refrigerant Management Program (RMP) was reviewed to determine an appropriate assumption for the annual frequency of repair for refrigerant-containing appliances that use ALD monitoring systems or are inspected annually or quarterly and are leaking above the threshold annual leak rates in this final action. These data suggest that most appliances with refrigerant charge sizes greater than 50 pounds are repaired once per year, with the exception of larger (>500 pounds) cold storage systems, which are repaired about twice per year on average (CARB 2009a).[31] This analysis assumes that there would be a similar relationship between appliances that are subject to this final rule (under subsection (h) of the AIM Act) as there is for the appliances subject to California's RMP.

Repair effectiveness and baseline leak rates. For all equipment types and sizes, post-repair leak rates reflect California Air Resources Board (CARB) (2009a) estimates, which were based on EPA's Vintaging Model and Intergovernmental Panel on Climate Change (IPCC)/Technology and Economic Assessment Panel (TEAP) (2005) recommendations. The modeled leak rates represent an outcome in which a post-repair leak rate of zero is not achieved. This assumption therefore may be more conservative than what may be actually achieved once this rule is implemented (i.e., this may assume more post-repair leakage than actually occurs). This is because the GWP-weighted amount of emissions prevented by a given leak repair equals the number of weeks divided by 52 weeks per year, multiplied by the difference of the leak rate pre-repair and the leak rate post-repair) multiplied by the charge size multiplied by the GWP of the refrigerant leaking. A higher post-repair leak rate results in a lower change in leak rate, which results in a lower estimate of emissions prevented. On the other hand, some owners and operators may choose to repair the leak to the point where the leak rate does not trigger further leak repair, in which case the assumed non-zero post-repair leak rate may be more reflective of actual industry behavior.

[31] Cold storage systems that are repaired twice are assumed to follow a modified standard repair outcome. After the first leak is repaired, the system is assumed to leak for six weeks (without ALD) or 10 weeks (with ALD) at the post-repair leak rate. At that point, the system is assumed to experience a failure such that six weeks (without ALD) or 10 weeks (with ALD) after the original repair the system has leaked a qualifying amount of refrigerant to require a second repair.

Table A-3 below presents the final leak rate assumptions by equipment sector, type, and size for refrigerant-containing appliances that are affected by the leak repair requirements (i.e., are expected to leak above the leak rate thresholds).[32] The percentage of each equipment type that is experiencing a qualifying leak was presented earlier in section 3.2 of this document.

Table A-2 – Leak Rate Assumptions by Equipment Sector, Type, and Size

Leak Rate Threshold	***Appliance Sector***	***Equipment Type***	***Equipment Size***	***Baseline Annual Leak Rate (for Equipment Requiring Repair)***	***Annual Post-repair Leak Rate***
10%	CC	School & Tour Bus AC	Sub-small	13%	10%
		Transit Bus AC	Sub-small	14%	8%
		Passenger Train AC	Sub-small	10%	2%
		Chiller	Medium	13% – 16%	2%
			Large	14% – 16%	2%
20%	CR	Modern Rail Transport	Sub-small	37%	19%
		Vintage Rail Transport	Sub-small	42%	15%
		Condensing Unit	Sub-small	22%	15%
		Marine Transport	Small	37%	10%
			Medium	29% – 37%	10%
			Large	29%	10%
		Rack	Medium	27%	10%
			Large	27%	10%
		Cold Storage	Large	30% – 34%	10%
30%	IPR	IPR	Medium	43% – 45%	7%
			Large	43% – 45%	7%

Source: EPA (2023f)

Leak Inspection

The final rule would result in incremental compliance costs to appliance owners and operators who would need to conduct leak inspections when leaks are identified that exceed the annual threshold leak

[32] The average reference case annual leak rates shown in Table A-2 are based on actual leak rate data reported to the CARB RMP. For sub-small equipment, the annual post-repair leak rates are based on the average Vintaging Model leak rate (if lower than the leak rate threshold for the equipment type) or the quintile 1 or quintile 2 leak rate from the modeled leak rate distributions (see Appendix A for more information).

rate (i.e., 10% for CC, 20% for CR, or 30% for IPR). For CR and IPR appliances with refrigerant charge sizes between 15 and 500 pounds and for CC and other appliances with charge sizes at or above 15 pounds, leak inspections are annual, and for CR and IPR appliances with refrigerant charge sizes between 500 and 1,500 pounds, leak inspections are quarterly. As a baseline, the cost analysis conservatively assumes that annual leak inspections are not currently performed. This assumption may overestimate compliance costs since some owners and operators have indicated they conduct regular leak inspections to ensure that systems continue to function properly, to avoid recurring refrigerant top-off costs, or they are required to do so based on state regulations. Although the cost analysis assumes no annual leak inspections in the baseline, when estimating baseline emissions, the real-world prevalence of ALD in each subsector is empirically captured in the average leak rates in the Vintaging Model (i.e., unlike costs, emissions are not conservatively estimated, nor are they overestimated due to this assumption). For CR and IPR appliances with refrigerant charge sizes above 1,500 pounds, ALD monitoring is required, so no additional inspections are assumed for these appliances. The incorporation of ALD in the model partially ameliorates the overestimation of costs for leak inspection but does not account for all overestimation due to current leak inspection practices.

Unit Cost and Savings Assumptions

Leak inspection. Leak inspections were assumed to require, on average, four hours per system per inspection for CR and IPR appliances, and two hours for CC appliances.

An hourly labor rate of $58.02 was assumed for leak repair and inspection, based on the median hourly earnings of $27.63 for the Heating, Air-conditioning, and Refrigeration Mechanics and Installers occupational group (49-9021) from the Bureau of Labor Statistics (BLS 2023a), plus 110 percent to account for overhead ($30.39). All costs in this report are reported in 2022 dollars, unless otherwise noted.

ALD systems. Direct and indirect ALD system costs include the capital expenditure to purchase the hardware (e.g., detector, sensors), plus installation costs and operations and maintenance (O&M) costs associated with annual system maintenance, certification, and data tracking/storage. These costs are assumed to vary by system size (e.g., number of zones and sensors) and are summarized in Table A-4 , with direct ALD systems requiring higher material and installation costs than indirect systems because a separate monitoring device and zone sensors are required (see supplemental analysis [33] titled American Innovation and Manufacturing Act of 2020—Subsection (h): Automatic Leak Detection *Systems* for more

[33] Abt 2024. Available in the docket (EPA-HQ-OAR-2022-0606) for this rulemaking at *https://www.regulations.gov*.

information). For the purposes of this analysis, 50 percent of refrigerant-containing appliance owners were assumed to install direct ALD systems and 50 percent of refrigerant-containing appliance owners are assumed to install indirect ALD systems, which offer additional monitoring capabilities that automatically provide certain reporting and recordkeeping requirements. For new CR and IPR refrigerant-containing appliances containing 1,500 pounds or more of refrigerant and installed on or after January 1, 2026, owners or operators are required to purchase and install an ALD system upon installation or within 30 days of installation. By January 1, 2027 owners or operators with existing CR and IPR appliances containing 1,5000 pounds of refrigerant or more that were installed on or after January 1, 2017, and before January 1, 2026, and before January 1, 2026, are required to purchase and install an ALD system. This analysis assumes 10–21 percent of existing and new CR and IPR appliances would already have regularly calibrated ALD systems installed[34], which is assumed to last the full lifetime of the equipment. In subsequent years, new refrigerant-containing appliances entering the market would also experience costs to purchase and install an ALD system. The upfront costs to purchase and install a direct ALD system were annualized over a 5-year period using a rate of 9.8 percent,[35] whereas indirect ALD system owners are not assumed to finance the material and installation costs. Owners and operators were also assumed to experience annual O&M costs throughout the life of the ALD system (Abt, 2024).

Table A-3 – Unit Cost Assumptions for ALD Systems

System Size	*Material Cost*	*Labor Hours*	*Installation Cost*	*Equipment and Installation Cost*	*Annualized Equipment and Installation Cost (Years 1-5)*	*Annual O&M Cost*
Direct ALD System						
1,500–2,000	$9,000	16	$928	$9,928	$2,606	$1,250
2,000+	$9,850	20	$1,160	$11,010	$2,890	$1,440
Indirect ALD System						
1,500-2,000	$2,850	8	$464	$3,314	NA	$950
2,000+	$2,650	10	$580	$3,230	NA	$1,000

Source: (Abt, 2024)

[34] This assumes that 10 percent of CR and IPR equipment under 1,500 pounds would have ALD already installed or would be expected to install ALD in the absence of this rulemaking, 16 percent of appliances 1,500–2,000 pounds , and that 21 percent of CR and IPR equipment have ALD as required in California (based on population of California relative to the United States) for appliances greater than 2,000 lb.

[35] Businesses are expected to treat ALD systems as capital assets and therefore it is assumed that businesses would be able to access financing for their purchase, if desired, for a loan tenure of five years. The discount rate used in this analysis is consistent with the RIA to the Allocation Framework Rule, which identified a weighted average cost of capital in this sector of 9.8 percent (EPA 2023a).

Leak repair. Repair costs are calculated as the base cost of making the repair or retrofit, including labor, parts, refrigerant recovery, and verification tests.[36] These costs are assumed to vary by system size, where leak repairs on a sub-small or small refrigerant-containing appliances are assumed to be relatively simpler and less costly than repairs on medium and large refrigerant-containing appliances. The base costs associated with each outcome were estimated as described below.

- **Standard repair.** Leak repair costs for a "standard repair" are based on assumptions in CARB (2009a). CARB (2009a) surveyed RACHP service contractors and technicians to validate these cost assumptions. Although the CARB estimates did not cover appliances with charge sizes less than 50 pounds, repair costs for these smaller appliances were extrapolated from the CARB estimates.
- **Extension repair.** An "extension repair" is assumed to involve the repair of a major component such as a compressor and is based on costs presented in Stratus (2009).[37]
- **Retrofit.** Retrofit costs were also based on Stratus (2009); this analysis assumed that the cost to retrofit an entire appliance was between two to three times the cost of the compressor or major component.

As noted above, lower leak rate thresholds will result in leaks being repaired sooner than under the current approach. The analysis assumes that repairs are conducted six or ten weeks earlier as a result of these requirements. Thus, the repair costs attributable to the rule are based on the time cost of conducting those repairs six or ten weeks earlier. The interest cost (at 7 percent, 3 percent, and 2 percent per year) of the base repair cost is attributed to the rule; this cost is referred to below as the "effective cost of repair."[38]

An "effective cost" approach was also taken for the cost of retrofitting. Refrigerant-containing appliances that are retrofitted as a result of the regulation are assumed to be retrofitted five years earlier than they would have been under current practices. Thus, the effective cost of retrofitting attributable to the rule is the cost of borrowing the funds for retrofitting for five years at 7 percent, 3 percent, or 2 percent per year.

Table A-5 below presents the base and effective cost assumptions by repair, appliance charge size, and whether the appliance is using ALD. For retrofit outcomes, the base costs presented do not include

[36] Industry input suggested that verification tests are already conducted as standard practice during servicing events. Moreover, because initial and follow-up verification tests can both be conducted during the same service appointment, this requirement is not expected to result in additional servicing events. Time required to conduct the verification tests is included in the estimated time to conduct the repair.
[37] Stratus (2009) obtained estimates of retail prices for typical replacement compressors from a supplier (ThermaCom Ltd.).
[38] CARB used a similar approach—i.e., estimating the effective cost of repair—in developing its economic impact estimates for its High-Global Warming Potential Stationary Source Refrigerant Management Program (CARB 2009b).

the additional cost of replacing the entire refrigerant charge with virgin refrigerant. These costs can be sizable considering, for instance, charge sizes can exceed 10,000 pounds in some systems. For the standard and extension repair outcomes, the cost of refrigerant recharge is not included since it is assumed that the owner or operator would have topped off the system in the absence of the regulatory requirements.

Table A-4 – Unit Cost Assumptions for Leak Repair[a,b,c]

Appliance Size	*Total Labor Hours*	*Parts*	*Refrigerant Recovery*	*Total Base Cost for Labor, Parts, and Recovery*	*Effective Cost of Early Repair / Retrofit (without ALD)*			*Effective Cost of Early Repair / Retrofit (with ALD)*		
					7% Discount Rate	*3% Discount Rate*	*2% Discount Rate*	*7% Discount Rate*	*3% Discount Rate*	*2% Discount Rate*
Standard Repair										
Sub-small, Small	8	$135	$269	$868	$7.6	$3.3	$2.2	-	-	-
Medium	12	$404	$471	$1,572	$13.8	$5.9	$3.9	$22.9	$9.8	$6.5
Large	16	$808	$876	$2,612	$22.9	$9.8	$6.5	$38.1	$32.7	10.9
Extension Repair										
Sub-small, Small	20.25	$3,501	$269	$4,945	$43.3	$18.5	$12.4	-	-	-
Medium	20.25	$12,768	$471	$14,415	$126	$54.1	$36.0	$210	$90.1	$60.1
Large	20.25	$12,768	$876	$14,819	$130	$55.6	$37.0	$216	$92.6	$61.7
Retrofit[c]										
Sub-small, Small	20.25	$10,297	$269	$11,741	$2,616–$2,774	$1,278–$1,355	$881–$935	-	-	-
Medium	20.25	$27,459	$471	$29,105	$6,684–$7,837	$3,266–$3,829	$2,252–$2,641	$7,915–$8,173	$3,867–$3,993	$2,667–$2,754
Large	20.25	$27,459	$876	$29,509	$8,322–$9,214	$4,066–$4,502	$2,804–$3,104	$8,345–$40,352	$4,077–$19,715	$2,812–$13,596

Source: for Standard Repair Labor Hours, Parts, and Recovery Costs: CARB (2009a); for Extension Repair and Retrofit: Stratus (2009).

[a] Assumptions for small appliances were proxied for sub-small equipment containing between 15 and 50 49 pounds of refrigerant.

[b] Total base cost is calculated by multiplying the total labor hours by the labor rate ($58.02) and adding the additional costs associated with parts and refrigerant recovery.

[c] Effective costs for repair and retrofit of appliances varies based on the charge size of the appliance replaced.

Refrigerant savings. By causing leaks to be repaired earlier, the regulations would result in refrigerant cost savings for system operators. Refrigerant cost savings are calculated based on the difference between the baseline and post-repair leak rates, multiplied by the charge size, over the six weeks earlier that each repair was conducted (or ten weeks earlier for appliances using an ALD system). An average price of $4 per pound was assumed for all refrigerants, based on the average price of HFC-134a, R-404A, R-407A and R-507 assumed in the RIA for Phasing Down Production and Consumption of HFCs (EPA 2021).

On a per system basis, effective refrigerant savings range from $0.20 for sub-small school bus AC up to $4,699 for large IPR systems.

Leak repair expected costs and savings. Expected costs and burden reductions per model appliance were estimated on a weighted basis, taking into account the proportion of appliances assumed to reach each leak repair outcome and the unit costs and savings associated with each outcome. Expected costs and savings were estimated in the Vintaging Model in a disaggregated manner, distinguishing between appliance sectors, types, sizes, and refrigerant type (EPA 2023f).

Abatement assumptions

Annual Environmental impacts of Leak Repair and Inspection

Similar to the methodology for estimating costs and savings, environmental impacts were estimated using a model equipment approach. For equipment with 15 or more pounds of refrigerant containing an HFC or a substitute for an HFC that has a GWP above 53, environmental impacts were scaled up industry-wide based on the total number of affected equipment using EPA's Vintaging Model and the approach outlined in Section 3.2.

Environmental impacts are calculated as the refrigerant emissions prevented by repairing or retrofitting a leaking system earlier than would have been done if waiting for the system performance to decline. EPA estimates this to be on average six weeks (or ten weeks if systems are using ALD monitoring). Avoided refrigerant emissions are calculated based on the difference between the baseline and post-repair leak rates (shown in Table A-3 above), multiplied by the charge size, over the six weeks or ten weeks earlier that each repair was conducted. The amount of avoided refrigerant emissions is weighted by an average GWP. For all equipment types, weighted-average GWPs are based on average charge sizes, refrigerant type, and stock of affected equipment modeled in the Vintaging Model (EPA 2023f).

Table A-5 – Average 2026 GWP Assumptions by Equipment Type, Size, and Refrigerant Type

Sector	*Equipment Type*	*Equipment Size*	*Weighted-Average GWP*
CC	School & Tour Bus AC	Sub-Small	1,430

Sector	*Equipment Type*	*Equipment Size*	*Weighted-Average GWP*
	Transit Bus AC	Sub-small	1,430
	Passenger Train AC	Sub-small	1,602
	Chiller	Medium	1,279 – 1,794
		Large	1,279 – 1,388
CR	Modern Rail Transport	Sub-small	2,676
	Vintage Rail Transport	Sub-small	1,430
	Condensing Unit	Sub-small	3,937
	Marine Transport	Small	3,482
		Medium	2,708 – 3,482
		Large	2,708
	Rack	Medium	2,701
		Large	2,701
	Cold Storage	Large	3,937
IPR	IPR	Medium	1,400 – 1,663
		Large	1,400 – 3,157

Source: EPA (2023f)

The environmental impacts for the extension repair are assumed to be equivalent to the environmental impacts of a standard repair. This analysis does not take into account the additional 30 days (or longer) that the system is leaking between filing the extension and when the actual repair takes place, which could result in overestimating the avoided emissions as a result of the extension request. However, because refrigerant-containing appliances requiring an extension repair have typically more complicated or catastrophic leaks, an extension repair as a result of the regulations would still be taking place earlier than it would under the baseline scenario, and emissions would still be avoided.

Although emission reductions associated with retrofit are anticipated, none are calculated in this analysis. The emission reductions associated with retrofit fall outside of the one-year timeframe of this analysis (i.e., end users have 30 days to make the initial repair, 30 days to prepare and submit a retrofit plan, and then a full year to complete the retrofit and repair all additional leaks), and thus are not included. Furthermore, because this analysis only considers a one-year period, it does not include emission reductions from preventing a chronically leaking appliance from continued operation over a longer time period than one year.

On a per appliance basis, effective emission reductions range from 0.03 metric tons of carbon dioxide (CO_2) equivalent ($MTCO_2eq$) for sub-small school bus AC systems up to 2,503 $MTCO_2eq$ for very large cold storage refrigeration systems (EPA 2023f).

Model Equipment Expected Environmental Impacts.

Expected environmental impacts per model equipment were estimated on a weighted basis, taking into account the proportion of appliances assumed to reach each leak repair outcome and the avoided refrigerant emissions associated with each outcome. Expected environmental impacts were estimated in the model in a disaggregated manner, distinguishing between equipment sectors, types, sizes, and refrigerant type. The expected avoided refrigerant emissions per model equipment type (as described above) were multiplied by the number of each type of equipment assumed to experience leaks above the rule's threshold leak rates (see section 3.2). This yields aggregate environmental impacts for the United States as a whole as shown in Table A-7 below (EPA 2023f).

Table A-6 – Expected Emissions Reductions in 2026 by Equipment Type and Size

Sector	*Equipment Type*	*Equipment Size*	*GHG Emissions Avoided ($MTCO_2eq$)*
CC	School & Tour Bus AC	Sub-small	3,100
	Transit Bus AC	Sub-small	1,900
	Passenger Train AC	Sub-small	1,100
	Chiller	Medium	724,200
		Large	27,500
CR	Modern Rail Transport	Sub-small	1,400
	Vintage Rail Transport	Sub-small	1,900
	Condensing Unit	Sub-small	77,800
	Marine Transport	Small	75,700
		Medium	386,300
		Large	8,300
	Rack	Medium	876,000
		Large	913,400
	Cold Storage	Large	163,700
IPR	IPR	Medium	59,500
		Large	2,065,800

Future Annual Environmental Impacts of Leak Repair and Inspection

The analysis described above estimates one-year environmental impacts based on the current distribution of HFC appliances in use. However, because the use of HFCs will change over the next decade due to the phase-down of HFCs in accordance with the AIM Act 2024 Allocation Rule, environmental impacts for the requirements of this rule will also change. Future environmental impacts were estimated using a model equipment, facility, and entity approach. Environmental impacts were then scaled up industry-wide based on the total number of affected appliances anticipated in 2030, 2040, and 2050.

Several assumptions were made to simplify the process of determining the number of affected appliances and the environmental impacts of leak repair in 2030, 2040, and 2050:

- Appliances used in later years are assumed to have the same leak rates and refrigerant charge sizes as those in the 2026 baseline scenario.
- The same proportion of standard repairs, extension repairs, and retrofits are assumed for all years.
- The affected HFC appliances in 2026 are assumed to grow according to the growth rate, lifetime, and transitions in EPA's Vintaging Model—with the adjustments described below.

The growth in stock of HFC appliances was adjusted to account for the Allocation Framework rule, the 2024 Allocation Rule RIA addendum, and the 2023 Technology Transitions RIA addendum. Environmental impacts from the transition away from HFCs were quantified and recently presented in the RIA addendum for the EPA final rulemaking, *Regulatory Impact Analysis Addendum: Impact of the Technology Transitions Rule* (EPA 2023b). To avoid double-counting environmental impacts, this analysis assumes that HFC CR, CC, and IPR appliances begin transitioning away from HFCs in accordance with the transition scenario presented in the 2023 Technology Transitions RIA Addendum.[39]

Appliance-specific average GWP values were also updated to reflect the specific mix of HFC refrigerants assumed in 2030, 2040, and 2050, as shown in Table A-8 . GWP values in 2030, 2040, and 2050 include HFCs and substitutes such as HFOs and HCFOs, but did not include other substitutes such as CO_2, ammonia, or hydrocarbons.[40] Affected equipment modeled in EPA's Vintaging Model, which was the basis for the RIA analysis for the AIM Allocation Framework Rule and the RIA Addendum for

[39] Different types of appliances are assumed to transition in different years as presented in the 2023 Technology Transitions Rule RIA Addendum (EPA 2023b).

[40] Given the GWPs of HFOs, HCFOs, CO_2, ammonia, and hydrocarbons are very low compared to regulated HFCs, the is not expected to affect the weighted-average GWP significantly.

the 2024 Allocation Rule, were distributed into three size categories (as discussed in section 3.2) and therefore all size categories for some equipment types have the same weighted-average GWP.

Table A-7 – Average GWP Assumptions by Equipment Type, Size, and Refrigerant Type for 2030, 2040, and 2050

Sector	***Equipment Type***	***Equipment Size***	***Weighted-Average GWP***		
			2030	***2040***	***2050***
CC	School & Tour Bus AC	Sub-small	1,430	1,430	1,430
	Transit Bus AC	Sub-small	1,430	1,430	1,430
	Passenger Train AC	Sub-small	1,602	1,602	1,602
	Unitary AC	Sub-small	1,717	836	730
	Chiller	Medium	1,122 – 1,832	716 – 1,887	0 – 698
		Large	1,122 – 1,182	716 – 896	618 – 625
CR	Modern Rail Transport	Sub-small	2,676	2,676	2,676
	Vintage Rail Transport	Sub-small	1,430	-	-
	Condensing Unit	Sub-small	3,937	3,937	-
	Marine Transport	Small	3,274	2,817	2,431
		Medium			
		Large	2,554 – 3,274	2,242 – 2,817	1,957 – 2,431
	Rack	Medium	2,554	2,242	1,957
		Large	2,510	2,417	-
	Cold Storage	Large	2510	2417	-
IPR	IPR	Medium	3,937	3,937	-
		Large	1,340 – 1,639	1,078 – 1,442	485 – 517

Environmental impacts on a per-appliance basis were then calculated in the same manner outlined in above and were multiplied by the estimated affected appliances in 2030, 2040, and 2050 described above as shown in Table A-9.

Table A-8 : Expected Emissions Reductions by Equipment Type, Size, and Refrigerant Type for 2030, 2040, and 2050

Sector	***Equipment Type***	***Equipment Size***	***MTCO2eq***		
			2030	***2040***	***2050***
CC	School & Tour Bus AC	Sub-small	3,300	3,800	4,100
	Transit Bus AC	Sub-small	2,000	2,300	2,500
	Passenger Train AC	Sub-small	1,200	1,300	1,400
	Chiller	Medium	678,200	324,200	197,700
		Large	25,200	19,500	14,700
CR	Modern Rail Transport	Sub-small	1,500	1,600	1,700
	Vintage Rail Transport	Sub-small	800	-	-
	Condensing Unit	Sub-small	64,700	19,900	-
	Marine Transport	Small	86,900	95,200	92,700

		Medium	445,500	488,800	476,100
		Large	12,400	14,900	14,600
	Rack	Medium	752,200	174,000	-
		Large	840,300	200,800	-
	Cold Storage	Large	197,900	82,700	-
IPR	IPR	Medium	52,200	26,800	3,500
		Large	2,463,100	1,559,000	111,100

Note: By 2040, there are no longer any HFC refrigerants assumed in vintage rail transport systems. By 2050, there are no longer any HFC refrigerants assumed in condensing units, cold storage, and rack systems.

Appendix B. Vintaging Model Leak Rate Distributions

The Vintaging Model simulates equipment emissions and consumption using average leak rates, consistent with *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC 2006). These average leak rates represent the full spectrum of potential equipment leak events, in which equipment may experience negligible or more significant and/or catastrophic leaks. In order to simulate a more real-world distribution of leak rates, equipment stock was distributed into quintiles, each containing 20 percent of units, where the leak rate distributions equal the weighted average leak rate modeled in the Vintaging Model for each equipment type. The representative leak rate for each quintile was estimated such that each subsector has at least 20 percent of its stock (i.e., one quintile) above the threshold leak rate.

Table B-1 summarizes the leak rate distributions for equipment containing 15 or more pounds of refrigerant considered in the analysis.

For most subsectors, the quintiles were established in increments of 25% percent above or below the average leak rate (i.e., quintile 1 is 50 percent below, quintile 2 is 25 percent below, quintile 3 is the average, quintile 4 is 25 percent above, and quintile 5 is 50 percent above). However, for some subsectors, the average leak rate modeled in the Vintaging Model was significantly below the threshold leak rate, such that the upper quintile leak rate did not exceed the threshold leak rate. In those cases, the fifth quintile leak rate was set to be significantly higher than the average leak rate to ensure that each subsector had some portion of equipment stock above the leak rate threshold and therefore was affected by the final rulemaking. In those cases, the quintile 1 through 4 values were also manipulated such that the weighted average leak rate across all five quintiles still equaled the average leak rate (i.e., quintile 3).[41]

Table B-1 – Leak Rate Distributions for Refrigerant-Containing Appliances

Sector	Equipment Type	Vintaging Model Subsector[a]		Quintile					Average Leak Rate
				1	2	3	4	5	
Subsectors with charge sizes greater than 15 pounds									
CC	Passenger Train AC	Passenger Train AC	% Relative to Average	0.88	1.1	1.4	1.6	495	2.1
			Assumed Leak Rate (%)	0.018	0.023	0.029	0.034	10[b]	

[41] Because the average Vintaging Model leak rate for certain subsectors (e.g., chillers, IPR) are significantly lower than the threshold leak rates of 10% for comfort cooling and 30% for IPR, it is not possible for the weighted average leak rate across the quintiles to equal the average leak rate using the percentages above.

Sector	Equipment Type	Vintaging Model Subsector[a]		Quintile 1	2	3	4	5	Average Leak Rate
CC	School & Tour Bus AC	School & Tour Bus AC[c]	% Relative to Average	50	75	100	125	150	10
			Assumed Leak Rate (%)	4.8	7.2	10	12	14	
CR	Rail Transport	Vintage Rail Transport	% Relative to Average	25	50	100	150	175	36
			Assumed Leak Rate (%)	15	24	36	48	57	
CR	Condensing Unit	HCFC-22 Large Condensing Units (Medium Retail Food)	% Relative to Average	50	75	100	125	150	15
			Assumed Leak Rate (%)	6.5	11	15	19	23	
CC	Transit Bus AC	Transit Bus AC	% Relative to Average	50	75	100	125	150	10
			Assumed Leak Rate (%)	5	7.5	10	12	15	
CR	Rail Transport	Modern Rail Transport	% Relative to Average	50	75	100	125	150	33
			Assumed Leak Rate (%)	17	25	33	41	50	
CC	Chiller	CFC-11 Centrifugal Chillers[d]	% Relative to Average	0	0	0	0	850	3.2
			Assumed Leak Rate (%)	0	0	0	0	16	
CC	Chiller	CFC-12 Centrifugal Chillers[d]	% Relative to Average	0	0	0	0	700	2.8
			Assumed Leak Rate (%)	0	0	0	0	14	
CC	Chiller	R-500 Chillers[d]	% Relative to Average	0	0	0	0	700	2.8
			Assumed Leak Rate (%)	0	0	0	0	14	
CC	Chiller	CFC-114 Chillers[d]	% Relative to Average	0	0	0	0	750	3.0
			Assumed Leak Rate (%)	0	0	0	0	15	
CC	Chiller	Screw Chillers[d]	% Relative to Average	0	0	0	0	1300	2.6
			Assumed Leak Rate (%)	0	0	0	0	13	
CC	Chiller	Scroll Chillers[d]	% Relative to Average	0	0	0	0	1300	2.6
			Assumed Leak Rate (%)	0	0	0	0	13	
CC	Chiller	Reciprocating Chillers[d]	% Relative to Average	0	0	0	0	850	2.6
			Assumed Leak Rate (%)	0	0	0	0	13	
IPR	IPR	CFC-11 Industrial Process Refrigeration[d]	% Relative to Average	0	0	0	0	850	8.5

Sector	Equipment Type	Vintaging Model Subsector[a]		Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	Average Leak Rate
			Assumed Leak Rate (%)	0	0	0	0	43	
IPR	IPR	CFC-12 Industrial Process Refrigeration[d]	% Relative to Average	0	0	0	0	1250	9.0
			Assumed Leak Rate (%)	0	0	0	0	45	
IPR	IPR	HCFC-22 Industrial Process Refrigeration	% Relative to Average	0	0	0	0	500	8.6
			Assumed Leak Rate (%)	0	0	0	0	43	
CR	Cold Storage	CFC-12 Cold Storage	% Relative to Average	0	50	75	100	275	12
			Assumed Leak Rate (%)	0	6.1	9.2	12	34	
CR	Cold Storage	HCFC-22 Cold Storage	% Relative to Average	0	50	75	100	275	11
			Assumed Leak Rate (%)	0	5.5	8.3	11	30	
CR	Cold Storage	R-502 Cold Storage	Assumed Leak Rate (%)	0	50	75	100	275	11
			% Relative to Average	0	5.6	8.4	11	31	
CR	Rack	CFC-12 Large Retail Food	Assumed Leak Rate (%)	50	75	100	125	150	22
			% Relative to Average	11	16	22	27	32	
CR	Rack	R-502 Large Retail Food	Assumed Leak Rate (%)	50	75	100	125	150	22
			Assumed Leak Rate (%)	11	16	22	27	32	
CR	Marine Transport	Merchant Fishing Transport	% Relative to Average	50	75	100	125	150	33
			Assumed Leak Rate (%)	17	25	33	41	50	
CR	Marine Transport	Reefer Ships	% Relative to Average	50	75	100	125	150	23
			Assumed Leak Rate (%)	12	17	23	29	35	

Note: Values may not sum due to independent rounding

[a] Vintaging Model subsectors are often defined by the ODS that was original used, as that affects the transition choices. This analysis does not consider the effects the final rule may have on ODS emissions.

[b] The assumed leak rate percentages for this equipment type quintile exceeds the 10 percent threshold rate for comfort cooling systems, but is shown as equal to 10 percent due to rounding.

[c] 33 percent of units in the School & Tour Bus AC sector are modeled with a charge size above 15 lbs.

[d] The average leak rate modeled does not equal the average leak rate for these subsectors in the Vintaging Model.

Althought the leak inspection and repair provisions only apply to refrigerant-containing appliances with a charge size of 15 pounds or greater, the requirement to use reclaimed refrierant applies to a few subsectors that have smaller charge sizes. The leak rate distribution for these subsectors are shown in Table B-2.

Table B-2 – Leak Rate Distributions for Additional Refrigerant-Containing Appliances

Sector	Equipment Type	Vintaging Model Subsector		Quintile					Average Leak Rate
				1	2	3	4	5	
Subsectors with charge sizes less than 15 pounds									
IPR	Ice Makers	Ice Makers[a]	% Relative to Average	15	30	45	60	350	3.0
			Assumed Leak Rate (%)	0.45	0.90	1.4	1.8	11	
CR	Road Transport	Road Transport	% Relative to Average	50	75	100	125	150	33
			Assumed Leak Rate (%)	17	25	33	41	50	
CR	Intermodal Containers	Intermodal Containers	% Relative to Average	50	75	100	125	150	21
			Assumed Leak Rate (%)	10	16	21	26	31	

[a] The average leak rate modeled does not equal the average leak rate for these subsectors in the Vintaging Model.

Appendix C. Detailed Costs by Equipment – Leak Repair and Inspection

Table C-1 – Total Annual Refrigerant Savings in 2030 (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate by Equipment Type

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate		2% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2030	2030	2030	2030	2030	2030	2030
Leak Repair			**-$20,873,100**	**$19,963,000**	**-$910,100**	**$9,509,100**	**-$11,364,000**	**$6,517,600**	**-$14355500**
CC	School & Tour Bus AC	Sub-Small	-$20,700	$2,400,800	$2,380,100	$1,139,800	$1,119,100	$780,600	$759,900
	Transit Bus AC	Sub-Small	-$12,400	$850,500	$838,100	$403,800	$391,400	$276,500	$264,100
	Train AC	Sub-Small	-$6,500	$132,700	$126,200	$63,000	$56,500	$43,200	$36,700
	Chiller	Medium	-$4,100,500	$7,985,200	$3,884,700	$3,817,700	-$282,800	$2,619,000	-$1,481,500
	Chiller	Large	-$192,000	$140,900	-$51,100	$67,000	-$125,000	$45,900	-$146,100
CR	Modern Rail Transport[a]	Sub-Small	-$5,400	$108,000	$102,600	$51,300	$45,900	$35,100	$29,700
	Condensing Unit	Sub-Small	-$146,400	$2,903,400	$2,757,000	$1,378,700	$1,232,300	$944,300	$797,900
	Vintage Rail Transport[a]	Sub-Small	-$5,600	$40,300	$34,700	$19,200	$13,600	$13,100	$7,500
	Rack[a]	Medium	-$2,936,100	$1,648,800	-$1,287,300	$782,300	-$2,153,800	$535,700	-$2,400,400
	Rack[a]	Large	-$3,280,300	$1,023,800	-$2,256,500	$483,900	-$2,796,400	$331,000	-$2,949,300
	Marine Transport[a]	Small	-$260,200	$318,800	$58,600	$151,500	-$108,700	$103,800	-$156,400
	Marine Transport[a]	Medium	-$1,342,500	$1,518,300	$175,800	$725,900	-$616,600	$498,000	-$844,500
	Marine Transport[a]	Large	-$47,600	$15,300	-$32,300	$7,200	-$40,400	$4,900	-$42,700
	Cold Storage	Large	-$233,500	$39,500	-$194,000	$18,800	-$214,700	$12,900	-$220,600

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate		2% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2030	**2030**	**2030**	**2030**	**2030**	**2030**	**2030**
IPR	IPR	Medium	-$284,900	$127,300	-$157,600	$60,900	-$224,000	$41,800	-$243,100
	IPR	Large	-$7,998,500	$709,400	-$7,289,100	$338,100	-$7,660,400	$231,800	-$7,766,700
Leak Inspection			**$0**	**$73,942,500**	**$73,942,500**	**$73,942,500**	**$73,942,500**	**$73,942,500**	**$73,942,500**
CC	School & Tour Bus AC	Sub-Small	$0	$8,195,200	$8,195,200	$8,195,200	$8,195,200	$8,195,200	$8,195,200
	Transit Bus AC	Sub-Small	$0	$2,903,400	$2,903,400	$2,903,400	$2,903,400	$2,903,400	$2,903,400
	Train AC	Sub-Small	$0	$450,200	$450,200	$450,200	$450,200	$450,200	$450,200
	Chiller	Medium	$0	$10,755,700	$10,755,700	$10,755,700	$10,755,700	$10,755,700	$10,755,700
	Chiller	Large	$0	$147,900	$147,900	$147,900	$147,900	$147,900	$147,900
CR	Modern Rail Transport[a]	Sub-Small	$0	$736,900	$736,900	$736,900	$736,900	$736,900	$736,900
	Condensing Unit	Sub-Small	$0	$19,665,500	$19,665,500	$19,665,500	$19,665,500	$19,665,500	$19,665,500
	Vintage Rail Transport[a]	Sub-Small	$0	$273,900	$273,900	$273,900	$273,900	$273,900	$273,900
	Rack[a]	Medium	$0	$10,881,300	$10,881,300	$10,881,300	$10,881,300	$10,881,300	$10,881,300
	Rack[a]	Large	$0	$3,545,700	$3,545,700	$3,545,700	$3,545,700	$3,545,700	$3,545,700
	Marine Transport[a]	Small	$0	$2,069,900	$2,069,900	$2,069,900	$2,069,900	$2,069,900	$2,069,900
	Marine Transport[a]	Medium	$0	$10,520,000	$10,520,000	$10,520,000	$10,520,000	$10,520,000	$10,520,000
	Marine Transport[a]	Large	$0	$50,500	$50,500	$50,500	$50,500	$50,500	$50,500
	Cold Storage	Large	$0	$35,800	$35,800	$35,800	$35,800	$35,800	$35,800
IPR	IPR	Medium	$0	$1,338,300	$1,338,300	$1,338,300	$1,338,300	$1,338,300	$1,338,300
	IPR	Large	$0	$2,372,300	$2,372,300	$2,372,300	$2,372,300	$2,372,300	$2,372,300
Automatic Leak Detection			**$0**	**$26,491,300**	**$26,491,300**	**$26,491,300**	**$26,491,300**	**$26,491,300**	**$26,491,300**
CC	School & Tour Bus AC	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Transit Bus AC	Sub-Small	$0	$0	$0	$0	$0	$0	$0

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate		2% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2030	**2030**	**2030**	**2030**	**2030**	**2030**	**2030**
	Train AC	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Chiller	Medium	$0	$0	$0	$0	$0	$0	$0
	Chiller	Large	$0	$0	$0	$0	$0	$0	$0
CR	Modern Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Condensing Unit	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Vintage Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Rack[a]	Medium	$0	$7,725,900	$7,725,900	$7,725,900	$7,725,900	$7,725,900	$7,725,900
	Rack[a]	Large	$0	$7,725,900	$7,725,900	$7,725,900	$7,725,900	$7,725,900	$7,725,900
	Marine Transport[a]	Small	$0	$0	$0	$0	$0	$0	$0
	Marine Transport[a]	Medium	$0	$172,800	$172,800	$172,800	$172,800	$172,800	$172,800
	Marine Transport[a]	Large	$0	$188,300	$188,300	$188,300	$188,300	$188,300	$188,300
	Cold Storage	Large	$0	$447,700	$447,700	$447,700	$447,700	$447,700	$447,700
IPR	IPR	Medium	$0	$0	$0	$0	$0	$0	$0
	IPR	Large	$0	$10,230,700	$10,230,700	$10,230,700	$10,230,700	$10,230,700	$10,230,700
Reporting & Recordkeeping			**$0**	**$10,770,884**	**$10,770,884**	**$10,770,884**	**$10,770,884**	**$10,770,884**	**$10,770,884**
CC, CR, and IPR	CC and CR 15–50 lb.	15-50	$0	$6,115,317	$6,115,317	$6,115,317	$6,115,317	$6,115,317	$6,115,317
	CC, CR, and IPR ≥50 lb.	50+	$0	$4,655,567	$4,655,567	$4,655,567	$4,655,567	$4,655,567	$4,655,567
Total			**-$20,873,100**	**$131,167,684**	**$110,294,584**	**$120,713,784**	**$99,840,684**	**$117,722,284**	**$96,849,184**

Totals may not sum due to independent rounding.

[a] The costs and savings for Modern Rail Transport, Vintage Rail Transport, Rack, and Marine Transport reflect the requirements to use reclaimed material starting in 2029.

Table C-2 – Total Annual Refrigerant Savings in 2040 (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate by Equipment Type

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate		2% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2040	2040	2040	2040	2040	2040	2040
Leak Repair			**-$12,790,700**	**$13,708,900**	**$918,200**	**$6,531,600**	**-$6,259,100**	**$4,476,900**	**-$8,313,800**
CC	School & Tour Bus AC	Sub-Small	-$23,600	$2,731,800	$2,708,200	$1,296,900	$1,273,300	$888,200	$864,600
	Transit Bus AC	Sub-Small	-$14,100	$967,700	$953,600	$459,400	$445,300	$314,600	$300,500
	Train AC	Sub-Small	-$7,200	$145,400	$138,200	$69,100	$61,900	$47,300	$40,100
	Chiller	Medium	-$2,984,500	$5,210,500	$2,226,000	$2,490,600	-$493,900	$1,708,500	-$1,276,000
	Chiller	Large	-$204,000	$149,600	-$54,400	$71,200	-$132,800	$48,800	-$155,200
CR	Modern Rail Transport[a]	Sub-Small	-$5,700	$115,600	$109,900	$54,900	$49,200	$37,600	$31,900
	Condensing Unit	Sub-Small	-$45,100	$893,900	$848,800	$424,500	$379,400	$290,700	$245,600
	Vintage Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Rack[a]	Medium	-$705,500	$366,600	-$338,900	$173,600	-$531,900	$118,800	-$586,700
	Rack[a]	Large	-$814,000	$230,800	-$583,200	$108,700	-$705,300	$74,300	-$739,700
	Marine Transport[a]	Small	-$331,200	$405,700	$74,500	$192,900	-$138,300	$132,100	-$199,100
	Marine Transport[a]	Medium	-$1,711,400	$1,932,200	$220,800	$923,800	-$787,600	$633,700	-$1,077,700
	Marine Transport[a]	Large	-$65,300	$19,800	-$45,500	$9,300	-$56,000	$6,400	-$58,900
	Cold Storage	Large	-$96,500	$16,500	-$80,000	$7,800	-$88,700	$5,400	-$91,100
IPR	IPR	Medium	-$167,100	$74,700	-$92,400	$35,800	-$131,300	$24,500	-$142,600
	IPR	Large	-$5,615,500	$448,100	-$5,167,400	$213,100	-$5,402,400	$146,000	-$5,469,500
Leak Inspection			**$0**	**$47,214,200**	**$47,214,200**	**$47,214,200**	**$47,214,200**	**$47,214,200**	**$47,214,200**

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate		2% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2040	2040	2040	2040	2040	2040	2040
CC	School & Tour Bus AC	Sub-Small	$0	$9,325,000	$9,325,000	$9,325,000	$9,325,000	$9,325,000	$9,325,000
	Transit Bus AC	Sub-Small	$0	$3,303,700	$3,303,700	$3,303,700	$3,303,700	$3,303,700	$3,303,700
	Train AC	Sub-Small	$0	$493,300	$493,300	$493,300	$493,300	$493,300	$493,300
	Chiller	Medium	$0	$6,949,600	$6,949,600	$6,949,600	$6,949,600	$6,949,600	$6,949,600
	Chiller	Large	$0	$157,000	$157,000	$157,000	$157,000	$157,000	$157,000
CR	Modern Rail Transport[a]	Sub-Small	$0	$788,700	$788,700	$788,700	$788,700	$788,700	$788,700
	Condensing Unit	Sub-Small	$0	$6,054,800	$6,054,800	$6,054,800	$6,054,800	$6,054,800	$6,054,800
	Vintage Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Rack[a]	Medium	$0	$1,992,300	$1,992,300	$1,992,300	$1,992,300	$1,992,300	$1,992,300
	Rack[a]	Large	$0	$398,500	$398,500	$398,500	$398,500	$398,500	$398,500
	Marine Transport[a]	Small	$0	$2,634,200	$2,634,200	$2,634,200	$2,634,200	$2,634,200	$2,634,200
	Marine Transport[a]	Medium	$0	$13,365,200	$13,365,200	$13,365,200	$13,365,200	$13,365,200	$13,365,200
	Marine Transport[a]	Large	$0	$41,900	$41,900	$41,900	$41,900	$41,900	$41,900
	Cold Storage	Large	$0	$13,100	$13,100	$13,100	$13,100	$13,100	$13,100
IPR	IPR	Medium	$0	$785,700	$785,700	$785,700	$785,700	$785,700	$785,700
	IPR	Large	$0	$911,200	$911,200	$911,200	$911,200	$911,200	$911,200
Automatic Leak Detection			**$0**	**$17,473,700**	**$17,473,700**	**$17,473,700**	**$17,473,700**	**$17,473,700**	**$17,473,700**
CC	School & Tour Bus	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Transit Bus AC	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Train AC	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Chiller	Medium	$0	$0	$0	$0	$0	$0	$0
	Chiller	Large	$0	$0	$0	$0	$0	$0	$0

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate		2% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2040	2040	2040	2040	2040	2040	2040
CR	Modern Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Condensing Unit	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Vintage Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Rack[a]	Medium	$0	$2,764,700	$2,764,700	$2,764,700	$2,764,700	$2,764,700	$2,764,700
	Rack[a]	Large	$0	$2,764,700	$2,764,700	$2,764,700	$2,764,700	$2,764,700	$2,764,700
	Marine Transport[a]	Small	$0	$0	$0	$0	$0	$0	$0
	Marine Transport[a]	Medium	$0	$261,500	$261,500	$261,500	$261,500	$261,500	$261,500
	Marine Transport[a]	Large	$0	$290,700	$290,700	$290,700	$290,700	$290,700	$290,700
	Cold Storage	Large	$0	$202,300	$202,300	$202,300	$202,300	$202,300	$202,300
IPR	IPR	Medium	$0	$0	$0	$0	$0	$0	$0
	IPR	Large	$0	$11,189,800	$11,189,800	$11,189,800	$11,189,800	$11,189,800	$11,189,800
Reporting & Recordkeeping			**$0**	**$7,860,124**	**$7,860,124**	**$7,860,124**	**$7,860,124**	**$7,860,124**	**$7,860,124**
CC, CR, and IPR	CC and CR 15–50 lb.	15-50	$0	$4,629,656	$4,629,656	$4,629,656	$4,629,656	$4,629,656	$4,629,656
	CC, CR, and IPR ≥50 lb.	50+	$0	$3,230,469	$3,230,469	$3,230,469	$3,230,469	$3,230,469	$3,230,469
Total			**-$12,790,700**	**$86,256,924**	**$73,466,224**	**$79,079,624**	**$66,288,924**	**$77,024,924**	**$64,234,224**

Totals may not sum due to independent rounding.

[a] The costs and savings for Modern Rail Transport, Vintage Rail Transport, Rack, and Marine Transport reflect the requirements to use reclaimed material starting in 2029.

Table C-3 – Total Annual Refrigerant Savings in 2050 (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate by Equipment Type

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate		2% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2050	2050	2050	2050	2050	2050	2050
Leak Repair			**-$7,068,700**	**$11,896,900**	**$4,828,200**	**$5,670,700**	**-$1,398,000**	**$3,887,400**	**-$3,181,300**
CC	School & Tour Bus AC	Sub-Small	-$25,600	$2,959,500	$2,933,900	$1,405,000	$1,379,400	$962,200	$936,600
	Transit Bus AC	Sub-Small	-$15,300	$1,048,400	$1,033,100	$497,700	$482,400	$340,900	$325,600
	Train AC	Sub-Small	-$7,800	$157,500	$149,700	$74,800	$67,000	$51,200	$43,400
	Chiller	Medium	-$2,709,700	$4,629,300	$1,919,600	$2,212,700	-$497,000	$1,517,900	-$1,191,800
	Chiller	Large	-$210,800	$154,700	-$56,100	$73,600	-$137,200	$50,400	-$160,400
CR	Modern Rail Transport[a]	Sub-Small	-$6,200	$125,200	$119,000	$59,400	$53,200	$40,700	$34,500
	Condensing Unit	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Vintage Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Rack[a]	Medium	$0	$0	$0	$0	$0	$0	$0
	Rack[a]	Large	$0	$0	$0	$0	$0	$0	$0
	Marine Transport[a]	Small	-$373,600	$457,700	$84,100	$217,600	-$156,000	$149,100	-$224,500
	Marine Transport[a]	Medium	-$1,931,300	$2,178,900	$247,600	$1,041,800	-$889,500	$714,700	-$1,216,600
	Marine Transport[a]	Large	-$72,900	$21,700	-$51,200	$10,200	-$62,700	$7,000	-$65,900
	Cold Storage	Large	$0	$0	$0	$0	$0	$0	$0
IPR	IPR	Medium	-$59,800	$26,800	-$33,000	$12,800	-$47,000	$8,800	-$51,000
	IPR	Large	-$1,655,700	$137,200	-$1,518,500	$65,100	-$1,590,600	$44,500	-$1,611,200
Leak Inspection			**$0**	**$39,939,300**	**$39,939,300**	**$39,939,300**	**$39,939,300**	**$39,939,300**	**$39,939,300**
CC	School & Tour Bus AC	Sub-Small	$0	$10,102,300	$10,102,300	$10,102,300	$10,102,300	$10,102,300	$10,102,300

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate		2% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2050	2050	2050	2050	2050	2050	2050
	Transit Bus AC	Sub-Small	$0	$3,579,100	$3,579,100	$3,579,100	$3,579,100	$3,579,100	$3,579,100
	Train AC	Sub-Small	$0	$534,200	$534,200	$534,200	$534,200	$534,200	$534,200
	Chiller	Medium	$0	$6,161,900	$6,161,900	$6,161,900	$6,161,900	$6,161,900	$6,161,900
	Chiller	Large	$0	$162,500	$162,500	$162,500	$162,500	$162,500	$162,500
CR	Modern Rail Transport[a]	Sub-Small	$0	$854,100	$854,100	$854,100	$854,100	$854,100	$854,100
CR	Condensing Unit	Sub-Small	$0	$0	$0	$0	$0	$0	$0
CR	Vintage Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0
CR	Rack[a]	Medium	$0	$0	$0	$0	$0	$0	$0
CR	Rack[a]	Large	$0	$0	$0	$0	$0	$0	$0
CR	Marine Transport[a]	Small	$0	$2,971,800	$2,971,800	$2,971,800	$2,971,800	$2,971,800	$2,971,800
CR	Marine Transport[a]	Medium	$0	$15,054,600	$15,054,600	$15,054,600	$15,054,600	$15,054,600	$15,054,600
CR	Marine Transport[a]	Large	$0	$39,200	$39,200	$39,200	$39,200	$39,200	$39,200
CR	Cold Storage	Large	$0	$0	$0	$0	$0	$0	$0
IPR	IPR	Medium	$0	$281,900	$281,900	$281,900	$281,900	$281,900	$281,900
IPR	IPR	Large	$0	$197,700	$197,700	$197,700	$197,700	$197,700	$197,700
Automatic Leak Detection			**$0**	**$5,713,900**	**$5,713,900**	**$5,713,900**	**$5,713,900**	**$5,713,900**	**$5,713,900**
CC	School & Tour AC	Sub-Small	$0	$0	$0	$0	$0	$0	$0
CC	Transit Bus AC	Sub-Small	$0	$0	$0	$0	$0	$0	$0
CC	Train AC	Sub-Small	$0	$0	$0	$0	$0	$0	$0
CC	Chiller	Medium	$0	$0	$0	$0	$0	$0	$0
CC	Chiller	Large	$0	$0	$0	$0	$0	$0	$0
CR	Modern Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate		2% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2050	2050	2050	2050	2050	2050	2050
	Condensing Unit	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Vintage Rail Transport[a]	Sub-Small	$0	$0	$0	$0	$0	$0	$0
	Rack[a]	Medium	$0	$0	$0	$0	$0	$0	$0
	Rack[a]	Large	$0	$0	$0	$0	$0	$0	$0
	Marine Transport[a]	Small	$0	$0	$0	$0	$0	$0	$0
	Marine Transport[a]	Medium	$0	$327,100	$327,100	$327,100	$327,100	$327,100	$327,100
	Marine Transport[a]	Large	$0	$335,900	$335,900	$335,900	$335,900	$335,900	$335,900
	Cold Storage	Large	$0	$0	$0	$0	$0	$0	$0
IPR	IPR	Medium	$0	$0	$0	$0	$0	$0	$0
	IPR	Large	$0	$5,050,900	$5,050,900	$5,050,900	$5,050,900	$5,050,900	$5,050,900
Reporting & Recordkeeping			**$0**	**$7,361,138**	**$7,361,138**	**$7,361,138**	**$7,361,138**	**$7,361,138**	**$7,361,138**
CC, CR, and IPR	CC and CR 15-50 lbs.[a]	15-50	$0	$4,097,624	$4,097,624	$4,097,624	$4,097,624	$4,097,624	$4,097,624
	CC, CR, and IPR ≥50 lbs.	50+	$0	$3,263,514	$3,263,514	$3,263,514	$3,263,514	$3,263,514	$3,263,514
Total			**-$7,068,700**	**$64,911,238**	**$57,842,538**	**$58,685,038**	**$51,616,338**	**$56,901,738**	**$49,833,038**

Totals may not sum due to independent rounding.

[a] The costs and savings for Modern Rail Transport, Vintage Rail Transport, Rack, and Marine Transport reflect the requirements to use reclaimed material starting in 2029.

Appendix D. Modeled servicing demand for equipment affected by reclamation provisions, by HFC gas

Projected reclaimed refrigerant demand, accounting for the leak repair provisions in the final rule, is shown by species and equipment type in the Table D-1 below. In 2029, when the mandatory use of reclaimed refrigerants for service takes effect, the required reclaimed refrigerants for service in the subsectors specified are estimated to be 1,417 MT HFC-32, 5,110 MT HFC-125, 3,381 MT HFC-134a, and 2,259 MT HFC-143a.[42]

Table D-1 – Service Demand of HFCs for Applicable Subsectors in 2029[a]

Sector	Refrigerant-Containing Equipment Type	Service Demand (MT)			
		HFC-32	HFC-125	HFC-134a	HFC-143a
Supermarket Systems		1,265	3,561	2,621	1,213
Refrigerated Transport	Road	82	730	191	402
	Vintage	0	0	10	0
	Modern Rail	0	2	5	2
	Intermodal Containers	0	3	298	3
	Marine	58	789	236	622
Automatic Commercial Ice Makers		11	25	22	16
Total		**1,417**	**5,110**	**3,381**	**2,259**

[a] Results by gas represent demand for HFCs both as neat gases and as constituent gases within specific blends. For example, a significant driver of demand for HFC-32, HFC-125, and HFC-134a in the above table is driven by estimated servicing demand for R-407A, a blend of these three gases.

From 2029 through 2050, the amount of reclaimed HFCs needed to service the applicable refrigerant-containing equipment types is expected to decrease, in both mass and CO_2e terms, as more refrigerant-containing equipment transitions to alternatives. Further, as refrigerant-containing equipment using higher-GWPs comes offline, the model assumes some of that can be recovered and reused, alleviating the

[42]These values represent the full demand and do not incorporate the rule's allowance that up to 15 percent of the amount may be from virgin material.

need for reclaimed material. Tables D-2 and D-3 show the projected demand for servicing the designated refrigerant-containing equipment types in metric tons and $MMTCO_2e$.

Table D-2 – Service Demand of HFCs for Applicable Subsectors, 2029-2050 (Metric Tons)

	HFC-32	**HFC-125**	**HFC-134a**	**HFC-143a**	**Total**
2029	1,417	5,110	3,381	2,259	12,168
2030	1,389	4,889	3,274	1,978	11,530
2031	1,348	4,685	3,147	1,747	10,927
2032	1,292	4,477	2,988	1,546	10,303
2033	1,223	4,292	2,808	1,402	9,725
2034	1,148	4,095	2,621	1,254	9,119
2035	1,077	3,915	2,440	1,117	8,548
2036	1,005	3,730	2,255	976	7,967
2037	919	3,524	2,072	897	7,411
2038	831	3,313	1,884	816	6,844
2039	742	3,097	1,693	733	6,266
2040	651	2,878	1,498	650	5,677
2041	558	2,653	1,300	565	5,076
2042	464	2,436	1,098	495	4,494
2043	404	2,300	964	439	4,106
2044	415	2,318	971	398	4,101
2045	425	2,349	978	372	4,124
2046	436	2,380	985	346	4,147
2047	446	2,411	992	319	4,168
2048	457	2,442	999	291	4,189
2049	468	2,472	1,006	263	4,209
2050	472	2,495	1,014	266	4,247

Table D-3 – Service Demand of HFCs for Applicable Subsectors, 2029-2050 ($MMTCO_2e$)

	HFC-32	HFC-125	HFC-134a	HFC-143a	Total
2029	1.0	17.9	4.8	10.1	33.8
2030	0.9	17.1	4.7	8.8	31.6
2031	0.9	16.4	4.5	7.8	29.6
2032	0.9	15.7	4.3	6.9	27.7
2033	0.8	15.0	4.0	6.3	26.1
2034	0.8	14.3	3.7	5.6	24.5
2035	0.7	13.7	3.5	5.0	22.9
2036	0.7	13.1	3.2	4.4	21.3
2037	0.6	12.3	3.0	4.0	19.9
2038	0.6	11.6	2.7	3.6	18.5
2039	0.5	10.8	2.4	3.3	17.0
2040	0.4	10.1	2.1	2.9	15.6
2041	0.4	9.3	1.9	2.5	14.0
2042	0.3	8.5	1.6	2.2	12.6
2043	0.3	8.0	1.4	2.0	11.7
2044	0.3	8.1	1.4	1.8	11.6
2045	0.3	8.2	1.4	1.7	11.6
2046	0.3	8.3	1.4	1.5	11.6
2047	0.3	8.4	1.4	1.4	11.6
2048	0.3	8.5	1.4	1.3	11.6
2049	0.3	8.7	1.4	1.2	11.6
2050	0.3	8.7	1.5	1.2	11.7

Appendix E. Detailed Description of Mitigation Actions Modeled Specific to the ER&R Rule

For the MACC analysis used as the primary methodological tool, updated abatement options were calculated for leak repair, ALD, use of reclaimed refrigerant, and fire suppression-related provisions contained in the final rule for each year of the analysis period (2026–2050). For calculating break-even costs, abatement potential was calculated on a consumption basis (i.e., cost per ton of carbon dioxide equivalent consumption abated), to be comparable to the abatement options presented in the Allocation Rules and 2023 Technology Transitions Rules analyses.

Leak repair of appliances

Abatement options for leak repair were calculated for the equipment types and sizes analyzed in this TSD, using the same approach for estimating costs and environmental impacts. In these options, because equipment owners would eventually add refrigerant to maintain that equipment in working order, it was assumed that emission reductions are equivalent to consumption reductions (i.e., that all avoided refrigerant emissions associated with repairing leaks translate into avoided consumption).

Table E-1 – Leak Repair abatement options added to MACC model for the subsection (h) Rule analysis in 2026

Abatement Option No.	Type	Equipment Type	Equipment Size	Breakeven Cost ($/mt$CO_2$e)
1	Leak repair	School & Tour Bus AC	Sub-small	$2,798.13
2	Leak repair	Transit Bus AC	Sub-small	$1,651.70
3	Leak repair	Passenger Train AC	Sub-small	$431.23
4	Leak repair	Chiller	Medium	$14.69
5	Leak repair		Large	$0.81
6	Leak repair	Modern Rail Transport	Sub-small	$534.15
7	Leak repair	Vintage Rail Transport	Sub-small	$349.47
8	Leak repair	Condensing Unit	Sub-small	$322.98
9	Leak repair	Marine Transport	Small	$21.46

10	Leak repair		Medium	$21.41
11	Leak repair		Large	$10.41
12	Leak repair	Rack	Medium	$21.56
13	Leak repair		Large	$9.24
14	Leak repair	Cold Storage	Large	-$0.22
15	Leak repair	IPR	Medium	$21.03
16	Leak repair		Large	-$0.62

Automatic leak detection systems

Abatement options for requiring ALD systems in existing and new systems were calculated for the equipment types and sizes shown in table A-4. The approach for estimating capital, installation, and O&M costs of ALD systems was based on the assumptions detailed in section 3.3 of this TSD. The leak repair and inspection costs, refrigerant savings, and environmental impacts of the ALD options were associated with repairs being conducted four weeks earlier (i.e., the incremental difference between the assumed six weeks earlier that repairs will be conducted without ALD and the 10 weeks earlier assumed for systems using ALD monitoring, as detailed in the draft RIA Addendum) and/or systems requiring fewer leak inspections (e.g., CR and IPR systems containing more than 1,500 pounds of refrigerant will switch from quarterly to annual inspections).

As with the added leak repair abatement options, it was assumed that emission reductions are equivalent to consumption reductions (i.e., that all avoided refrigerant emissions associated with repairing leaks translate into avoided consumption).

Table E-2 – ALD abatement options added to MACC model for the subsection (h) Rule analysis in 2026

Option No.	Type	Equipment Type	Equipment Size	Breakeven Cost ($/mt$CO_2$e)
17	ALD	Marine Transport	Medium	-$2.13
18	ALD		Large	-$4.89
19	ALD	Rack	Medium	-$22.01

Option No.	Type	Equipment Type	Equipment Size	Breakeven Cost ($/mt$CO_2$e)
20	ALD		Large	-$15.78
21	ALD	Cold Storage	Large	-$2.09
22	ALD	IPR	Large	-$4.47

Use of reclaimed HFCs for servicing of equipment starting January 1, 2029

To quantify costs and environmental impacts, a baseline for the use of reclamation in business-as-usual was first established. This baseline was derived from HFC reclamation totals modeled in the Vintaging Model[43] relative to modeled consumption for the RACHP and fire suppression sectors (i.e., new chemical demand and servicing demand) across the analysis period (2026-2050). The assumed percentage of demand met by reclaimed refrigerant in the baseline is 26.5 percent per year.

The costs and/or cost savings estimated for this activity included the refrigerant price difference in reclaimed refrigerant vs. virgin refrigerant. For the purposes of this analysis, it was assumed that the price of reclaimed refrigerant is 10 percent higher than virgin manufacture.[44] We provide a sensitivity analysis of this assumption in Appendix L.

The consumption impacts of this regulatory action needed to account for the proportion of virgin manufacture that the use of reclaimed refrigerant can offset. As discussed above, in our base case we assume there is already an increased recovery activity in the market, consistent with the compliance paths assumed in the Allocation Rules and the 2023 Technology Transitions Rule. In addition to accounting for those effects, we assume an additional offset stems from the final rule, which allows up to 15 percent virgin HFC material in reclaimed refrigerant.

This requirement was modeled as a series of abatement options that account for whether the equipment types for which reclaimed refrigerant must be used are covered or not covered by the leak repair requirements. For those equipment types covered by the leak repair requirements, the abatement options

[43] The Vintaging Model assumes disposal recovery from equipment reaching end-of-life in a particular year is used to meet consumption demand for the same subsector and substance (i.e., new chemical demand plus servicing demand) in the same year (i.e., reclamation). If disposal recovery is not sufficient to meet consumption demand, the remainder is assumed to be produced as virgin manufacture.
[44] This baseline amount of reclaim is not accounted for in the costs/benefits of the leak repair options above (e.g., the average refrigerant price is assumed to represent the cost of virgin refrigerant).

further distinguish between: a) leak repair above the leak threshold; and b) additional servicing and/or repair that would be conducted that is below the leak rate threshold.

- *Leak repair above the leak threshold, using reclaimed refrigerant, for marine transport, modern rail transport, vintage rail transport, and supermarket rack systems.*
    - To avoid double counting, these options supplant their equivalent, non-reclaim options listed above in Leak Repair and ALD (i.e., option numbers 6-7, 9-13, and 17-20), starting in 2029, when the requirement to use reclaim in servicing for the affected subsectors take effect. Costs and consumption impacts of leak repair using reclaimed refrigerant are calculated using the leak repair methods described in this TSD—but substituting the price of reclaimed refrigerant and applying the offsets for reclaim described above. EPA conservatively assumed that these measures would not result in an additional reduction in emissions beyond the emissions reductions from recovery of HFCs and avoided venting at disposal and servicing already included in the baseline.

Table E-3 – Combined leak repair, ALD, and reclaim abatement options added to MACC model for the subsection (h) Rule analysis in 2029

Option No.	Type	Equipment Type	Equipment Size	Breakeven Cost ($/mt$CO_2$e)
23	Leak repair – reclaim	Modern Rail Transport	Sub-small	$912.53
24	Leak repair – reclaim	Vintage Rail Transport	Sub-small	$596.35
25	Leak repair – reclaim	Marine Transport	Small	$38.02
26	Leak repair – reclaim		Medium	$37.94
27	Leak repair – reclaim		Large	$18.06
28	Leak repair – reclaim	Rack	Medium	$38.43
29	Leak repair – reclaim		Large	$16.15
30	ALD – reclaim	Marine Transport	Medium	$36.72
31	ALD – reclaim		Large	$24.71
32	ALD – reclaim	Rack	Medium	$29.67
33	ALD – reclaim		Large	$17.59

- *Servicing and/or repair below the leak threshold using reclaimed refrigerant, for marine transport, modern rail transport, vintage rail transport, and supermarket rack systems.*
    - For these abatement options, the amount of servicing was based on the difference between the amount of refrigerant replaced in each year (2029–2050) in equipment leaking above the leak threshold and the baseline amount of servicing demand modeled for these equipment types in the Vintaging Model. As for other reclaim options, the assumed costs reflect the price of reclaimed refrigerant, and the consumption impacts apply offset factors for the continued use of virgin material (i.e., up to 15%) and the baseline percentage of demand met by reclaim (i.e., 26.5%). There are no emission reductions associated with these options.

Table E-4 – Servicing reclaim abatement options added to MACC model for the subsection (h) Rule analysis in 2029

Option No.	Type	Equipment Type	Equipment Size	Breakeven Cost ($/mtCO₂e)
34	Servicing – reclaim	Modern Rail Transport	Sub-small	$0.33
35	Servicing – reclaim	Vintage Rail Transport	Sub-small	$0.62
36	Servicing – reclaim	Marine Transport	Small	$0.27
37	Servicing – reclaim		Medium	$0.27
38	Servicing – reclaim		Large	$0.34
39	Servicing – reclaim	Rack	Medium	$0.34
40	Servicing – reclaim		Large	$0.34

- *All servicing and/or repair for equipment types covered by the reclaimed refrigerant requirement but not covered by the leak repair requirement.*
    - For these abatement options, servicing demand was derived from EPA's Vintaging Model. As with other reclaim options, the assumed costs reflect the price of reclaimed refrigerant and the consumption reductions apply offset factors for the continued use of virgin material (i.e., up to 15%) and the baseline percentage of demand met by reclaim (i.e., 26.5%). There are no emission reductions associated with these options.

Table E-5 – Additional servicing reclaim abatement options added to MACC model for the subsection (h) Rule analysis in 2029

Option No.	Type	Equipment Type	Breakeven Cost ($/mtCO₂e)
41	Servicing other equipment types – reclaim	Road Transport	$0.30
42	Servicing other equipment types – reclaim	Intermodal Containers	$0.60
43	Servicing other equipment types – reclaim	Automatic Commercial Ice Makers	$0.38

Fire suppression equipment

An additional set of abatement options was run for rule provisions associated with restricting intentional releases (e.g., during installation, servicing, repairing, or disposal) of fire suppression equipment. Abatement options for total flooding fire suppression systems were calculated assuming a proportion of the annual leakage amount (assumed to be 0.5 percent) for total flooding systems estimated in the Vintaging Model is avoided through the venting restriction. Cost savings are assumed because losses during testing of new or existing systems would have been replaced before the unit enters or reenters service.[45]

Additionally, fire suppression equipment is required to use recycled fire suppression agent for both servicing existing equipment (beginning in 2026) and to install new equipment (beginning in 2030). Because the venting restriction and recycled agent requirement for servicing/repair of fire suppression equipment start in the same year (2026), the venting prohibition option assumes that intentional venting during testing would have been replaced with recycled agent, and therefore, as for other reclaim options in the RACHP sector, the assumed costs reflect the price of recycled agent and the consumption reductions apply the offset factors for the continued use of virgin material (i.e., up to 15%) and the baseline percentage of demand met by reclaim (i.e., 26.5%).

[45] An abatement option for the venting prohibition requirement is only applied to total flooding systems because streaming systems are not assumed to be serviced and therefore have no consumption benefits associated with avoiding leaks (i.e., losses from intentional venting are not replaced over the lifetime of the equipment). The potential emission benefits for streaming systems due to the venting prohibition are not calculated in this RIA addendum. Similarly, an abatement option for the servicing reclaim requirement is only applied to total flooding systems because streaming systems are not assumed to be serviced.

In addition, options associated with the requirement to use recycled agent in servicing (i.e., for normal operating leaks and servicing) for total flooding systems and filling of new fire suppression equipment for total flooding and streaming were considered. Costs and environmental impacts for these options were calculated using the same approach as that used for refrigeration and AC equipment. The venting prohibition option is estimated to have emission reductions analogous to 0.5 percent of leak emissions for total flooding fire suppression systems. There are no associated emission reductions for the use of recycled agent for servicing and initial installation in fire suppression equipment.

Table E-6 – Fire suppression abatement options added to MACC model for the subsection (h) Rule analysis in 2026 or 2030

Option No.	Type	Equipment Type	Breakeven Cost ($/mt$CO_2$e)
44	Venting prohibition – recycled	Fire Extinguishing: Flooding Agents	$0.26
45	Servicing– recycled	Fire Extinguishing: Flooding Agents	$0.26
46	Initial installation – recycled	Fire Extinguishing: Streaming Agents	$0.09
47	Initial installation – recycled	Fire Extinguishing: Flooding Agents	$0.26

Appendix F. Analysis of Alternative Reference Case

As discussed in section 3.1 of this document, the incremental costs and environmental impacts of the final ER&R rule depend in part on the degree to which industry would have otherwise undertaken measures such as improved leak repair and recovery even in the absence of this regulation. Prior analyses conducted by EPA have illustrated multiple potential compliance pathways in response to existing AIM Act regulations, some of which included measures that would partially fulfill the requirements of the ER&R rule. These include actions taken in the fire protection subsector, improved leak repair, and additional recovery at disposal.

As discussed in the 2023 Technology Transitions Rule RIA Addendum, these measures are not required to meet compliance with prior AIM Act regulations, and the degree to which industry would undertake them in the absence of explicit requirements is uncertain. Since these fire protection, leak repair, and enhanced recovery measures were not found to be required to meet compliance with the Allocation and 2023 Technology Transitions Rules, they are not included in the primary reference case for this analysis. However, as a bounding exercise, this appendix provides the resulting incremental environmental impacts of the final ER&R rule with an alternative reference case in which these measures are included. In other words, these measures are assumed to occur even in the absence of the ER&R Rule, thus illustrating a lower bound of the incremental environmental impacts of the rule.

Table F-1 below provides a summary of the specific measures previously assumed as compliance options for the Allocation and 2023 Technology Transitions Rules RIA and RIA Addenda which are included in the reference case in the alternative scenario provided in this appendix. Transitions to lower-GWP options as assumed in the 2023 Technology Transitions Rule RIA remain as part of the reference case under this alternative scenario as they do in the primary reference case.

Table F-1 – Reference Case Assumptions in ER&R Rule Base Case vs. Alternative Reference Case Scenario

Abatement Measure	***ER&R Alternative Reference Case Assumption***	***ER&R Base Case Assumption***
Leak Repair	Average leak rate for large RefAC equipment improves (i.e., is reduced) by 40% assumed in reference case. ER&R rule reclaim requirements only result in incremental emission reductions insofar as they require additional or earlier leak repairs beyond these levels.	No improvement in average leak rate for large RefAC equipment included in reference case beyond Vintaging Model BAU assumptions.
Disposal Recovery and Emissions	Improvement in end-of-life emissions rate to 3-4% of remaining equipment charge for large and small RACHP	No improvement in end-of-life emissions rate assumed in reference case beyond Vintaging Model BAU assumptions.

	equipment assumed in reference case. ER&R rule reclaim requirements do not result in incremental emissions reductions and recovery rates beyond these levels.	
Fire Suppression	Fire suppression sector makes transitions away from HFCs to low-GWP alternatives in reference case. ER&R measures therefore affect smaller universe of fire suppression equipment.	Fire suppression sector does not make transitions away from HFCs to low-GWP alternatives in reference case. ER&R measures affect larger universe of fire suppression equipment still using HFCs.
RACHP, Foams, and Aerosol Transitions	All transitions in the 2023 Technology Transitions RIA Addendum Base Case are assumed in the reference case.	All transitions in the 2023 Technology Transitions RIA Addendum Base Case are assumed in the reference case.

Table F-2 and Table F-3 below provide the total MAC costs and emissions reductions in the ER&R Alternative Reference Case and Base Case Scenarios.

Table F-2 – Incremental Annual Compliance Costs of MAC Abatement Measures under ER&R Alternative Reference Case and Base Case Scenarios (Millions 2022$)

	ER&R Alternative Reference Case Scenario			***ER&R Base Case***		
Year	Leak Repair	Reclamation	Fire Suppression	Leak Repair	Reclamation	Fire Suppression
2026	$69.5	$-	$0.1	$79.5	$-	$0.2
2030	$91.5	$2.2	$0.3	$88.3	$3.9	$0.8
2035	$78.8	$1.4	$0.2	$75.0	$3.1	$0.9
2040	$61.8	$1.6	$0.3	$57.5	$2.3	$0.9
2045	$45.2	$1.6	$0.4	$43.4	$1.8	$1.0
2050	$44.6	$2.1	$0.6	$43.3	$1.9	$1.0
PV (3% d.r.)	$1,183	$23	$5	$1,146	$38	$13

Table F-3 – Incremental Annual Emissions Reductions from MAC Abatement Measures under ER&R Alternative Reference Case and Base Case Scenarios ($MMTCO_2e$)

	ER&R Alternative Reference Case Scenario			***ER&R Base Case***		
Year	Leak Repair	Reclamation	Fire Suppression	Leak Repair	Reclamation	Fire Suppression
2026	3.09	-*	0.01	5.39	-*	0.01
2030	3.41	-	0.01	5.63	-	0.01
2035	2.97	-	0.00	4.62	-	0.01
2040	2.16	-	0.00	3.01	-	0.01
2045	1.23	-	0.00	1.53	-	0.01
2050	0.83	-	0.00	0.92	-	0.01

Total	58.05	-	0.12	88.49	-	0.21

*Reclaim requirements may lead to additional emissions reductions by inducing increased recovery of refrigerant at servicing and disposal that may otherwise be released or vented. As described elsewhere in this TSD, EPA has conservatively assumed that these measures do not yield incremental HFC emissions reductions beyond model BAU levels.

Overall, these results indicate that there would be approximately 34% less reductions in emissions under the alternative reference case assumptions, while the present value of total costs would be approximately 1% higher than those of the ER&R base case.

For abatement measures corresponding to leak repair and ALD provisions, overall avoided emissions reductions decrease under the alternative reference case scenario, since average reference case equipment leak rates are lower (thus yielding lower "available" emissions reductions from repairs). However, because in most cases the overall scope of equipment with leak rates above the ER&R rule leak rate threshold remains the same under either scenario, costs remain similar, albeit with small changes due to cases where additional equipment exceed the leak rate threshold or where the measure results in additional refrigerant savings attributable to the rule as a result of the alternative assumptions.

For abatement measures corresponding to Fire Suppression, the inclusion of transitions away from HFCs for the broader sector in the alternative the reference case results in a smaller universe of equipment affected by the rule's venting and use of recycled HFCs provisions. As a result, both emissions reductions and costs decrease under the alternative reference case scenario, relative to the base case.

Table F-4 below provides the costs under the alternative reference case scenario.

Table F-4 – Summary of Annual Values, Present Values, and Equivalent Annualized Values select years for the 2026–2050 Timeframe for Estimated Compliance Costs for this Rule (millions of 2022$, discounted to 2024) – Alternative Reference Case Scenario [a,b,c]

Year	Costs (2%, 3%, 7%)		
2026	$82		
2030	$103		
2035	$88		
2040	$70		
2045	$52		
2050	$53		
Discount rate	**2%**	**3%**	**7%**
PV	$1,507	$1,342	$886
EAV	$77	$77	$76

[a] Rows may not appear to add correctly due to rounding.
[b] Present values are calculated using end of year discounting.
[c] The annualized present value of costs are calculated as if they occur over a 25-year period.

Appendix G. SBREFA Assumptions and Methodology

This screening analysis finds that the rulemaking can be presumed not to have a ***significant economic impact on a substantial number of small entities (SISNOSE)***.

This section describes the approach and assumptions used to estimate the economic impact on small entities (businesses and governments) associated with the regulatory requirements for leak repair and use of automatic leak detection (ALD) systems for certain equipment using refrigerants containing HFCs with a GWP greater than 53 and certain substitutes; use of reclaimed HFCs in certain sectors or subsectors; the servicing, repair, disposal, or installation of fire suppression equipment that contains HFCs, as well as requirements related to technician training in the fire suppression sector; recovery of HFCs from cylinders; and reporting and recordkeeping; the decision matrix used to make the SISNOSE determination; and the aggregated small entities impacts.[46] The rulemaking applies to equipment used across a wide variety of businesses and government entities,[47] including school districts and cities. This analysis first assesses the economic impact to small businesses and small governments separately and then aggregates the impact across both types of entities to make a SISNOSE determination for the rulemaking.

Approach for Estimating the Economic Impact on Small Businesses

The analysis uses a model entity approach to estimate impacts on small businesses for the requirements for leak repair and use ALD; use of reclaimed HFCs in certain sectors or subsectors; the servicing, repair, disposal, or installation of fire suppression equipment that contains HFCs, requirements related to technician training in the fire suppression sector; and recovery of HFCs from cylinders. To estimate costs per small business, assumptions were developed for each industry category affected by the regulatory changes (i.e., the proportion of facilities that have appliances with refrigerant charges of 15 or more pounds) and the type and number of appliances per affected facility and business. Costs per model facility were developed to accurately reflect the range of compliance costs that a given small business owner or operator could experience from leak repair, leak inspection, ALD installation, and reporting and recordkeeping costs. Costs per model facility were then scaled to a model business on both an industry-specific and equipment-specific basis. Therefore, each model business reflects information about the

[46] Costs associated with certain several mobile end-uses (i.e., Modern Rail Transport, Passenger Train AC, Vintage Rail Transport, and Marine Transport) were not considered in this analysis, as it was determined that these equipment types are wholly owned and operated by large entities.
[47] The Regulatory Flexibility Act (RFA) defines small governments as the government of a city, county, town, township, village, school district, or special district with a population less than 50,000 (EPA 2022b).

average number of facilities a business has in a given industry category and equipment type (i.e., smaller businesses typically have fewer facilities per business than larger businesses).

The regulation also includes a requirement to recover refrigerant heels from disposable cylinders prior to disposal. Companies that sell and distribute HFCs, in particular refrigerant, will be impacted.

Model Facility and Small Business Cost Assumptions for Leak Repair and ALD Provisions

The model business approach is built up from the model equipment analysis described in Chapter 3 and model facility assumptions developed for the average number of refrigeration and air conditioning appliances and transit buses[48] per facility or business, for each industry category, as summarized in Table G-1 These assumptions were based on analysis of 2013 data reported under California's RMP, cross-walked with assumptions made by similar analyses (CARB 2009a; Stratus 2009) about equipment use by industry and reconciled with expert judgment.[49]

Table G-1 – Average Number of Systems per Facility in Industries Containing Appliances with 15 or More Pounds of HFC Refrigerant

Industry Category	Average Systems per Facility		
	CC	CR	IPR
Agriculture and Crop Support Services	1	2	-
Arts, Entertainment, and Recreation	1	-	
Beverage and Ice Manufacturing	1	-	1
Charter Bus Industry	1		
Durable Goods Wholesalers and Dealers	2	-	-
Educational Services	4	1	-

[48] Approximately 10% of transit buses are assumed to be operated by private industry (e.g., charter buses) (APTA 2022).
[49] Within each industry category, it was assumed that small businesses with annual revenue less than $200,000 do not utilize equipment with more than 15 pounds of refrigerant, given that these equipment typically cool larger spaces and equipment costs be cost prohibitive for these businesses (e.g., a typical commercial unitary air conditioning system can cost between $20,000 to $25,000, which would represent up to 25% of total annual revenue for a business with 2 CC units and an annual revenue of $200,000). Similarly, it was assumed that small businesses with revenue less than $500,000 would not utilize equipment with more than 1,500 pounds of refrigerant (i.e., would not have systems that require installation of ALD systems). Thus, these businesses would not have installed equipment affected by leak repair and inspection and ALD provisions of the rulemaking, respectively.

Industry Category	Average Systems per Facility		
	CC	CR	IPR
Food Manufacturing	1	2	-
General Merchandise Stores	1	2	
Grocery and Specialty Food Stores	1	2	-
Hospitals	2	-	-
Ice Rinks	1	-	2
Non-durable Goods Wholesalers and Dealers	1	2	-
Non-food Manufacturing	2	-	3
Office Buildings	3	-	-
Other Warehousing, Storage, and Transportation	4	-	-
Refrigerated Warehousing and Storage	1	2	-
Research and Development	2	-	-
Utilities	2	-	-
Warehouse Clubs and Supercenters	1	3	

Potential compliance costs for each model facility were developed to accurately reflect the range of compliance costs that a given small business owner or operator could experience from leak repair, leak inspection, ALD installation, and reporting and recordkeeping requirements. For each business, there are many potential configurations of equipment types, equipment sizes, and repair outcomes that determine compliance costs for stock above the leak rate threshold. Considering these multiple possibilities, "worst case" model facility assumptions were adopted for standard leak repair and extension leak repair outcomes. The "worst case" reflects the possibility that appliances with leak rates above the threshold leak rate are clustered in individual facilities, such that all of the eligible appliances in a single model facility might trigger inspection and repair. Within each facility, it is assumed that multiple units of the same appliance type are maintained in the same way (e.g., if a facility has two CR systems, both appliances are assumed to have similar leak rates), and thus experience the same leak repair outcomes.

Model facility scenarios were developed for each industry category based on how many different sizes of appliances the industry is assumed to use within each sector and the expected number of leak repair outcomes. Retrofit outcomes were determined to only occur to a maximum of one piece of equipment per model facility. Each scenario features a different combination of appliance sizes and leak repair outcomes, with likelihood of each leak repair outcome based on estimates in Appendix A.

Economic impacts to small businesses associated with ALD installation and maintenance were also developed using the model facility approach. Although the number of potential configurations of equipment are lower because CC equipment are exempt from ALD requirements and only CR and IPR equipment with charge sizes greater than 1,500 pounds are impacted, a larger number of facilities are impacted because ALD requirements apply to new and existing CR and IPR equipment installed on or after January 1, 2017 with charge sizes greater than 1,500 pounds.[50]

Expected compliance costs per model facility were estimated by multiplying the (a) unit cost assumptions described in Appendix A averaged across all equipment within a given size category for each sector plus the expected reporting and recordkeeping costs per facility, by the (b) model facility configurations for each industry sector. Costs to small businesses were then scaled based on the proportion of facilities-to-businesses for small businesses in each size category of each NAICS code in each industry category.

Some small businesses within each NAICS code and industry category, that operate appliances that are subject to the rule (i.e., CC, CR, and IPR equipment containing more than 15 pounds of refrigerant), are not expected to experience any compliance costs. This is because not all systems will leak above the threshold leak rates, and therefore do not require leak repair or inspection or the installation of ALD systems. However, these businesses may be subject to increased costs associated with the requirement to use reclaimed refrigerant for the servicing and/or repair of appliances, as discussed further below.

Small Business Cost Assumptions for Reclamation and Recycling Provisions

The final rulemaking institutes several requirements related to the reclamation and recycling of HFCs. A review of reporting under the AIM Act indicates that there are 37 EPA-certified reclaimers, of which 32 are small businesses. Under the final rule, HFC refrigerant sold as reclaimed can contain no more than 15 percent virgin HFC refrigerant, by weight. It is not known how much virgin refrigerant is currently

[50] For the purposes of this screening analysis, facilities experiencing leak repair and inspection costs are separate from facilities experiencing ALD costs.

used for blending with reclaimed refrigerant, and therefore it is assumed that reclaimers will experience negligible cost impacts associated with this requirement.

Reclaimers are subject to labeling and recordkeeping requirements. Costs for labeling and recordkeeping are based on the estimated burden time to prepare each reporting element and are discussed in further detail in the Information Collection Request associated with this rulemaking.

The rulemaking requires the use of reclaim refrigerant for the servicing and/or repair of refrigerant-containing appliances in certain subsectors and applications in the RACHP sector, including supermarket systems, refrigerated transport, and automatic commercial ice makers, and the use of recycled HFCs for the servicing and/or repair of fire suppression equipment, including both total flooding systems and streaming applications. Many of the businesses subject to the leak repair and ALD requirements of the rulemaking would also be impacted by the requirement to use reclaimed or recycled HFCs for servicing/repair of certain refrigeration appliances and fire suppression equipment. Additional industries using equipment not covered by the leak repair and ALD provisions (e.g., road transport, intermodal containers, automatic commercial ice machines, and fire suppression equipment) were also identified.

Small businesses are anticipated to experience costs associated with the requirement to use reclaim refrigerant for servicing/repair of supermarket systems, refrigerated transport, and automatic commercial ice makers and recycled agent for servicing/repair of fire suppression equipment.[51] Servicing demand for these appliances and systems estimated by EPA's Vintaging Model was distributed across businesses in proportion to their annual sales (Census Bureau 2020) and it was assumed that businesses would incur a 10 percent price increase per pound of reclaimed or recycled HFCs (i.e., $0.40 per pound based on an assumed cost of $4 per pound for virgin material).

Small Business Cost Assumptions for Fire Suppression Provisions

The final rulemaking also institutes several additional requirements for fire suppression equipment containing HFCs. Specifically, fire suppression equipment containing a regulated substance may not release into the environment, such as by intentional venting during testing and EPA is requiring that all entities that employ fire suppression technicians who maintain, service, repair, install, or dispose of fire suppression equipment containing HFCs must provide training. EPA does not anticipate economic impacts associated with the restriction on intentional releases. Costs associated with technician training are discussed in further detail in the Information Collection Request associated with this rulemaking.

[51] EPA's Vintaging Model does not assume streaming systems are serviced.

Furthermore, EPA is requiring that for the fire suppression sector where HFCs are used, the initial installation of fire suppression equipment, including both total flooding systems and streaming applications, must be with recycled HFCs, starting on January 1, 2030. A review of HFC fire suppression manufacturers indicates that 8 are small businesses. Manufacturers are anticipated to experience costs associated with the requirement to use recycled agent for the initial installation of fire suppression equipment. Demand for charging new fire suppression equipment estimated by EPA's Vintaging Model was distributed across businesses in proportion to their annual sales (Census Bureau 2020) and it was assumed that businesses would incur a 10 percent price increase per pound of recycled HFCs (i.e., $0.40 per pound).

Owners and operators of fire suppression equipment containing HFCs (including an HFC blend) dispose of this equipment by recovering the HFCs themselves or by arranging for HFC recovery by a fire suppression equipment manufacturer, distributor, or a fire suppressant recycler. EPA anticipates negligible to beneficial economic impacts associated with the requirement to recover HFCs from fire suppression equipment prior to disposal due to already established industry-wide practice to recover fire suppression agent and the resale value of recovered HFCs.

Small Business Cost Assumptions for Requiring Heel Recovery from Disposable Cylinders

The regulation also institutes a requirement to recover refrigerant heels from disposable cylinders (i.e., non-refillable cylinders), which are primarily used to charge and service stationary refrigeration and air-conditioning systems and fire suppression equipment. Disposable cylinders are specifically manufactured to be single use. These cylinders are charged with refrigerant, sold for use to fill or service equipment, and disposed (EIA 2018). Disposable cylinders are typically discarded with amounts of refrigerants still in the cylinders that will be emitted over time including from amounts commonly referred to as heels.

EPA is requiring that disposable cylinders that have been used for the servicing, repair, or installation of refrigerant-containing equipment or fire suppression equipment must be sent to a reclaimer, fire suppressant recycler, or a final processor for recovery of the heel. EPA is requiring that the recovered heel must be sent to a reclaimer for further processing.

Small Entities Potentially Subject to Refrigerant Heel Recovery Requirements

The requirement to remove heels from cylinders before disposal would directly impact those companies that sell or distribute or repackage refrigerant in such cylinders, as these companies would be required to return their used cylinder to a reclaimer or a final processor for heel recovery prior to disposal.

For this analysis, potentially affected entities are assumed to be producers, importers, exporters, reclaimers, and companies that sell and distribute HFCs (e.g., blenders, repackagers, and wholesalers or distributors of refrigerants) and disposal facilities (i.e., landfills or recycling facilities).[52] Table G-2 lists the potentially affected industries by NAICS code and the estimated number of small businesses affected.

Table G-2 – List of Industries Potentially Affected by the Prohibition of Disposable Cylinders by NAICS Code

NAICS Code	NAICS Industry Description	Size Standard in Millions of Dollars	Size Standard in Number of Employees	Estimated Number of Small Businesses Affected
325120	Industrial Gas Manufacturing		1,200	0[a]
562920	Materials Recovery Facilities	25		964[a]
423740	Refrigeration Equipment and Supplies Merchant Wholesalers		125	288[b]
423730	Warm Air Heating and Air-Conditioning Equipment and Supplies Merchant Wholesalers		175	1,017[b]
424690	Other Chemical and Allied Products Merchant Wholesalers		175	2,755[b]
562212	Solid Waste Landfill	47		609
238220	Plumbing, Heating, and Air-Conditioning Contractors	19		49,964

Source: Small Business Size Regulations, 3 CFR Part 121.201 (2023)

[a] Includes 32 known small business HFC reclaimers in addition to recycling facilities where disposable cylinders may be sent.

[b] It was assumed that 50 percent of businesses within these NAICS codes are refrigerant wholesalers and would be directly affected by the requirement to recover refrigerant heels from cylinders prior to disposal. It is also assumed that the

[52] For the purposes of this analysis, it is conservatively assumed that producers transport refrigerant primarily in containers larger than 30-lbs. cylinders and therefore the total inventory of 4.45 million disposable refrigerant cylinders, adjusted to account for the proportion of cylinders containing HFC or HFC blends with a GWP > 53, was distributed across importers, exporters, reclaimers, and companies that sell and distribute HFCs (e.g., blenders, repackagers, and wholesalers or distributors of refrigerants) defined by the NAICS codes in .

NAICS Code	NAICS Industry Description	Size Standard in Millions of Dollars	Size Standard in Number of Employees	Estimated Number of Small Businesses Affected

remaining 50 percent of businesses could be affected by the prohibition of disposable cylinders such that they are considered within the universe of potentially affected entities but are expected to experience minimal economic impacts.

[c] It was assumed that 50 percent of businesses within this NAICS code are refrigerant contractors and would be directly affected by the requirement to provide a certification statement if technicians evacuate a cylinder prior to disposal. It is assumed that the remaining 50 percent of businesses are other types of contractors (i.e., plumbing) that are not impacted by the rulemaking.

Estimated Economic Impacts of Requiring Refrigerant Heel Removal from Cylinders prior to Disposal

For the purposes of quantifying direct compliance costs for this analysis, it was assumed that producers, importers, exporters, reclaimers, and companies that sell and distribute refrigerant currently sell refrigerant using 4.455 million disposable cylinders,[53] adjusted to the proportion of cylinders containing HFC and blends containing HFCs versus other non-regulated substances such as hydrofluoroolefins (HFOs) estimated by EPA's Vintaging Model (EPA 2023f),[54] as shown in Table G-3.

Table G-3 – Assumed Cylinder Refrigerant Mix, 2028-2050

Year	Percentage of Cylinders containing HFC and HFC blends
2028	76%
2029	75%
2030	73%

[53] EPA estimates that there are 4.5 million refrigerant cylinders in circulation per year. Industry estimates that refillable cylinders account for between less than 1 percent and 10 percent of all 30-pound cylinders used, with a general assumption that the quantity of refillable cylinders as a percentage of all 30-pound cylinders used is closer to 1 percent (EPA 2024a). For the purposes of this analysis, it is assumed that 1 percent of all 30-pound cylinders sold in the United States are refillable (i.e., 45,000) and are therefore excluded from the heel recovery requirement.
[54] As explained in the RIA to the Allocation Framework Rule and associated addenda to that RIA, the Vintaging Model estimates the consumption and emissions from end-uses that traditionally relied on ODS and are transitioning to HFCs and other alternatives. The EPA (2023f) version of the model (VM IO file_v4.4_02.04.16_Final TT Rule 2023.xls) incorporates the transitions and practices anticipated to occur under the 2023 Technology Transitions RIA Base Case, which in turn incorporates provisions of that rule.

Year	Percentage of Cylinders containing HFC and HFC blends
2031	72%
2032	71%
2033	70%
2034	69%
2035	69%
2036	68%
2037	67%
2038	67%
2039	66%
2040	66%
2041	66%
2042	65%
2043	65%
2044	65%
2045	65%
2046	65%
2047	65%
2048	64%
2049	64%
2050	64%

All direct compliance costs are calculated as the difference between costs and savings currently incurred under the current business-as-usual (BAU) scenario and those estimated to be incurred under the provisions of the rulemaking.

Cost of transport. In the BAU scenario, disposable cylinders are assumed to travel from gas producer/filler to the wholesale distributor; wholesale distributor to end user/technician; and end user/technician to a disposal facility (e.g., landfill or steel recycler).

Transportation costs were updated to account for the distance traveled for each trip and the use of company fleets to transport cylinders based on a CARB (2011) analysis. It is assumed that companies already own or lease the proper vehicle fleet to transport cylinders.

Table G-4 summarizes distances per shipment for disposable cylinders. Based on the location of chemical production facilities around the United States, located primarily along the East Coast, Midwest, Southern United States, and California, it is assumed that a cylinder would travel an average of 1,000 miles from producer to the wholesale distributor. As assumed in CARB (2011), the distance between wholesale distributor and end-user/technician is assumed to be 25 miles. Other distances—75 miles from an end-user or wholesaler to a disposal facility and 50 miles from a distributor to a reclaimer— were also based on CARB (2011).

In the recovery scenario, it was assumed that approximately one-third of non-refillable cylinders would take one of three potential transportation scenarios: 1) cylinders would be returned directly to a reclaimer for heel recovery; 2) cylinders would be returned to the distributor and then to a disposal facility for heel recovery; or 3) cylinders would be sent directly to a disposal facility for heel recovery. Upon recovery of the heel, the disposal facility would store recovered refrigerant heels until the facility has accumulated enough refrigerant to send to a reclaimer. Based on an average heel of 0.96 pounds, it is assumed that a disposal facility would recover refrigerant from 25 cylinders in order to accumulate enough to fill one 30-pound cylinder (i.e., 24 pounds of refrigerant).

Table G-4 – Travel Distances for Disposable Cylinders Before Disposal

Trip	BAU	Recovery Scenario				
		Disposable-1[a]	Disposable-2[a]		Disposable-3[a]	
		End-user to Reclaimer to Disposal Facility	End-user to Distributor to Disposal	Disposal Facility to Reclaimer	End-user to Disposal Facility	Disposal Facility to Reclaimer

Gas producer/filler to wholesale distributor	1,000	1,000	1,000	NA	1,000	NA
Wholesale distributor to end user/technician	25	25	25	NA	25	NA
End user/technician to disposal facility	75	NA	NA	NA	75	NA
End user/technician to reclaimer	NA	50	NA	NA	NA	NA
End user/technician to distributor	NA	NA	25	NA	NA	NA
Wholesale distributor or reclaimer to disposal facility	NA	75	75	NA	NA	NA
Disposal facility to Reclaimer	NA	NA	NA	75[b]	NA	75[b]
Total Miles	**1,100**	**1,150**	**1,125**	**75**	**1,110**	**75**

[a] Assumed for one-third of shipped HFC cylinders.

[b] Disposal facilities are assumed to recover refrigerant from 25 cylinders before sending one 30-lb cylinder (containing 24 pounds of refrigerant) to a reclaimer.

Table G-5 provides additional assumptions related to fuel use and labor associated with transporting cylinders.

Table G-5 – Additional Transportation Assumptions

Parameter	Assumption
Average Fuel Efficiency	6.1 miles per gallon[a]
Diesel Fuel Cost	$4.034/gallon[b]

Parameter	Assumption
Average Truck Speed	50 miles per hour[c]
Labor Rate (Truck Transport)	$53.59[d]

[a] Geotab (2017)

[b] U.S. EIA (2024)

[c] CARB (2011)

[d] Labor rate for Heavy and Tractor-Trailer Truck Drivers from Bureau of Labor Statistic's Employer Costs for Employee Compensation – May 2022. Median hourly wages rates were multiplied by a factor of 2.1 to reflect the estimated additional costs for overhead (BLS 2023b).

Transportation costs were then calculated on a per cylinder basis. This analysis conservatively estimates transportation costs on a per cylinder basis assuming a truck could fit approximately 1,120 disposable cylinders (CARB 2011). Table G-6 summarizes the transport cost per cylinder based on the assumptions presented above.

To calculate annual transport costs per small business, it was assumed that a total of 4.445 million disposable cylinders are transported per year (adjusted for the proportion HFC and HFC blends in use per year, according to Table G-3) under both the BAU scenario and the provisions of the rulemaking. The number of cylinders transported before disposal per small business was distributed across businesses in proportion to their annual sales (Census Bureau 2020).

Table G-6 – Transportation Assumptions before Disposal per Cylinder

Scenario		Fuel Costs	Labor	Total
BAU	Disposable	$0.65	$1.05	$1.70
Recovery Scenario	Disposable-1 [a]	$0.68	$1.10	$1.78
	Disposable-2[a]	$0.66	$1.08	$1.74
	Disposable-2 (Disposal Facility)[b]	$0.002	$0.003	$0.005
	Disposable-3[a] (End-user)	$0.65	$1.05	$1.70

	Disposable-3 (Disposal Facility)[b]	$0.002	$0.003	$0.005

[a] Assumed for one-third of HFC cylinders sold per year.

[b] Disposal facilities are assumed to recover refrigerant from 25 cylinders before sending one 30-lb cylinder (containing 24 pounds of refrigerant) to a reclaimer.

Recovered heel. Under the recovery scenario, disposable cylinders are returned to a reclaimer prior to disposal containing a refrigerant heel that is recovered and sold back into the market. It was assumed that cylinders contain a heel of approximately 0.96 pounds based on CARB (2011) and expert judgment. Recovered refrigerant is assumed to be resold at approximately $4 per pound based on average refrigerant costs applied in EPA (2021a). The total annual savings associated with recovered heel was distributed across businesses in proportion to their assumed number of cylinders (as estimated under previous steps).

Reporting and Recordkeeping. Under the recovery scenario, companies that sell or distribute or repackage refrigerant in disposable cylinders, final processors, and refrigerant reclaimers and fire suppressant recyclers are also subject to reporting and recordkeeping requirements. Specifically, if a certified technician evacuates a disposable cylinder prior to discarding the cylinder, they must provide a certification statement certifying that the cylinder was evacuated to a level of 15 in-Hg for each disposable cylinder handled and discarded to the final processor. The final processor must keep this record for a period of 3 years. In addition, reclaimers and refrigerant distributors who supply reclaimed HFCs are subject to a discrete reporting requirement in 2027 and 2028 on the volume of reclaimed HFCs intended for servicing and/or repair of appliances in use in certain subsectors.

These reporting and recordkeeping costs are based on the estimated burden time to prepare each reporting element and are discussed in further detail in the Information Collection Request associated with this rulemaking.

Table G-7 summarizes the cost assumptions associated with the requirement to recover the refrigerant heel from disposable cylinders prior to disposal. Because the proportion of disposable cylinders changes per year as equipment is assumed to transition towards lower-GWP substitutes that are not regulated by this rulemaking, the sales test was performed for 2028 for which the highest proportion of HFC cylinders are assumed in circulation, as shown in Table G-3 (i.e., 76 percent), and therefore the highest potential cost impacts.

Table G-7 – Cost Assumptions for BAU and Rulemaking from Cylinder Heel Recovery Requirement

Assumption		BAU	Rulemaking			
			Reclaimer	Wholesaler or Distributor	Disposal Facility	Refrigerant Technician
Number of Disposable Cylinders Disposed (2028)		3,370,585	1,123,528	2,247,057		337,059[a]
Average Transport Cost per Cylinder		$1.70	$1.78	$1.72[b]	$0.005[c]	NA
Cylinder Heel Amount (lbs.) and Percent of Cylinder		0.96 (4%)	0.96 (4%)	0.96 (4%)	0.96 (4%)	0.96 (4%)
Average Refrigerant Price ($/lbs.)		$4	$4	$4	NA	NA
Reporting and Recordkeeping	Certification of Evacuation to 15-in Hg (per cylinder)[a]	NA	NA	NA	NA	$28.93
	Recordkeeping of Certification Statement (per cylinder)[a]	NA	NA	NA	$1.79	NA
	Reclaim Use Volume Report[d]	NA	$646.46	$530.21	NA	NA
	Labeling and Recordkeeping[e]	NA	$4,391	NA	NA	NA

[a] Approximately 10 percent of cylinders are assumed to be emptied directly by the end-user (i.e., refrigerant technician) and require a certification statement.

[b] Represents an average of the per-cylinder cost for wholesalers or distributors under disposable scenario 2 ($1.74 per cylinder) and disposable scenario 3 ($1.70 per cylinder) as shown in Table G-6

[c] Disposal facilities are assumed to recover refrigerant from 25 cylinders before sending one 30-lb cylinder (containing 24 pounds of refrigerant) to a reclaimer.

[d] Two-time report submitted by reclaimers and refrigerant distributors in 2027 and 2028 only.

[e] Represents one-time label redesign and recordkeeping costs for reclaimers noted in Section "Small Business Cost Assumptions for Reclamation and Recycling Provisions."

Summary of Economic Impacts. To inform the sales test, economic data about each affected industry—including number of firms by employment and receipts size—was obtained from the U.S. Census Bureau's Statistics of U.S. Businesses. Annualized compliance costs for 2028 for small businesses in each affected industry were compared to annual sales by firm size, as shown in Table G-8.

As shown, small businesses are expected to experience a positive economic impact (i.e., cost savings) or impact less than 1 percent of annual sales associated with the requirement to recover heels prior to cylinder disposal.

Table G-8 – Summary of Annual Economic Impacts from Cylinder Heel Recovery Requirement on Small Businesses by NAICS Code, 2028

Employee Size or Annual Revenue[a]	Number of Small Businesses Affected	Average Annual Sales per Firm	Assumed Cylinder Fleet per Firm or Cylinders Returned[b]	Annual Cost per Small Business			Total Annual Cost per Small Business	Impact as Percent of Annual Sales
				Average Incremental Annual Transport Costs	Heel Savings	Reporting & Recordkeeping		
Materials Recovery Facilities (Reclaimers)								
<5	13	$954,057	21	$1	-$81	$5,044	$4,964	0.52%
5-9	10	$2,727,975	60	$2	-$231	$5,044	$4,816	0.18%
10-19	6	$4,487,174	99	$4	-$380	$5,044	$4,668	0.10%
20-99	12	$11,410,450	251	$10	-$966	$5,044	$4,088	0.04%
100-499	1	$22,630,407	499	$19	-$1,915	$5,044	$3,148	0.01%
Refrigeration Equipment and Supplies Merchant Wholesalers								
<5	133	$835,730	18	$1	-$68	$621	$554	0.06%
5-9	63	$4,405,621	97	$4	-$359	$621	$266	0.004%
10-19	42	$7,287,619	161	$6	-$594	$621	$33	-0.001%
20-99	42	$27,967,987	616	$24	-$2,280	$621	-$1,635	-0.006%
100-149	23	$52,375,136	1,154	$45	-$4,269	$621	-$3,603	-0.007%
Warm Air Heating and Air-Conditioning Equipment and Supplies Merchant Wholesalers								

Employee Size or Annual Revenue[a]	Number of Small Businesses Affected	Average Annual Sales per Firm	Assumed Cylinder Fleet per Firm or Cylinders Returned[b]	Annual Cost per Small Business			Total Annual Cost per Small Business	Impact as Percent of Annual Sales
				Average Incremental Annual Transport Costs	Heel Savings	Reporting & Recordkeeping		
<5	391	$1,435,428	32	$1	-$120	$621	$502	0.03%
5-9	206	$4,027,378	89	$3	-$337	$621	$288	0.005%
10-19	170	$8,824,460	194	$8	-$738	$621	-$109	-0.002%
20-99	214	$28,135,080	620	$24	-$2,352	$621	-$1,707	-0.01%
100-199	36	$74,021,716	1,631	$63	-$6,187	$621	-$5,503	-0.01%
Other Chemical and Allied Products Merchant Wholesalers								
<5	1,526	$2,142,742	47	$2	-$180	$621	$442	0.02%
5-9	504	$6,251,162	138	$5	-$526	$621	$99.93	0.001%
10-19	345	$15,508,336	342	$13	-$1,306	$621	-$672	-0.005%
20-99	341	$35,522,558	783	$30	-$2,991	$621	-$2,340	-0.01%
100-149	39	$143,599,156	3,165	$122	-$12,091	$621	-$11,347	-0.01%
Materials Recovery Facilities (Recyclers)								
<5	380	$954,057	4	$0.02	-	$177	$177	0.02%

Employee Size or Annual Revenue[a]	Number of Small Businesses Affected	Average Annual Sales per Firm	Assumed Cylinder Fleet per Firm or Cylinders Returned[b]	Annual Cost per Small Business			Total Annual Cost per Small Business	Impact as Percent of Annual Sales
				Average Incremental Annual Transport Costs	Heel Savings	Reporting & Recordkeeping		
5-9	178	$2,727,975	10	$0.05	-	$505	$505	0.02%
10-19	151	$4,487,174	17	$0.08	-	$831	$831	0.02%
20-99	174	$11,410,450	43	$0.20	-	$2,114	$2,114	0.02%
100-499	49	$22,630,407	86	$0.40	-	$4,192	$4,193	0.02%
Solid Waste Landfill								
<$100	31	$67,016	1	$0.00	-	$12	$12	0.02%
$100-499	167	$342,772	1	$0.00	-	$63	$64	0.02%
$500-999	114	$898,137	3	$0.01	-	$166	$166	0.02%
$1,000-2,499	132	$1,998,150	8	$0.04	-	$370	$370	0.02%
$2,500-4,999	74	$4,132,387	16	$0.07	-	$766	$766	0.02%
$5,000-7,499	32	$6,717,014	26	$0.12	-	$1,244	$1,244	0.02%
$7,500-9,999	11	$9,181,946	35	$0.16	-	$1,701	$1,701	0.02%
$10,000-14,999	16	$13,290,027	51	$0.24	-	$2,462	$2,462	0.02%
$15,000-19,999	8	$18,042,643	69	$0.32	-	$3,342	$3,343	0.02%

Employee Size or Annual Revenue[a]	Number of Small Businesses Affected	Average Annual Sales per Firm	Assumed Cylinder Fleet per Firm or Cylinders Returned[b]	Annual Cost per Small Business			Total Annual Cost per Small Business	Impact as Percent of Annual Sales
				Average Incremental Annual Transport Costs	Heel Savings	Reporting & Recordkeeping		
$20,000-24,999	9	$18,842,779	72	$0.33	-	$3,491	$3,491	0.02%
$25,000-29,999	8	$23,202,340	88	$0.41	-	$4,298	$4,299	0.02%
$35,000-39,999	3	$37,499,500[c]	143	$0.66	-	$6,947	$6,947	0.02%
$40,000-49,999	4	$28,208,524	107	$0.50	-	$5,226	$5,226	0.02%
Refrigerant Technicians[d]								
<$100	10,648	$59,313	7	-	-	$203	$203	0.34%
$100-499	16,969	$284,372	7	-	-	$203	$203	0.07%
$500-999	8,208	$846,409	7	-	-	$203	$203	0.02%
$1,000-2,499	8,098	$1,836,287	7	-	-	$203	$203	0.01%
$2,500-4,999	3,327	$4,083,819	7	-	-	$203	$203	0.005%
$5,000-7,499	1,209	$7,105,073	7	-	-	$203	$203	0.003%
$7,500-9,999	576	$10,040,971	7	-	-	$203	$203	0.002%
$10,000-14,999	605	$14,071,905	7	-	-	$203	$203	0.001%
$15,000-19,999	326	$19,865,787	7	-	-	$203	$203	0.001%

Employee Size or Annual Revenue[a]	Number of Small Businesses Affected	Average Annual Sales per Firm	Assumed Cylinder Fleet per Firm or Cylinders Returned[b]	Annual Cost per Small Business			Total Annual Cost per Small Business	Impact as Percent of Annual Sales
				Average Incremental Annual Transport Costs	Heel Savings	Reporting & Recordkeeping		

[a] In thousands of dollars.

[b] Disposal facilities are assumed to recover refrigerant from 25 cylinders before sending one 30-lb cylinder (containing 24 pounds of refrigerant) to a reclaimer.

[c] Revenue data was not available for businesses in the $35,000-39,999 revenue category. For purposes of the sales test, revenue was estimated as the midpoint of the $35,000-39,999 revenue range (i.e., $37,499).

[d] Approximately 10 percent of cylinders are assumed to be emptied directly by the end-user (i.e., refrigerant technician) and require a certification statement. Cylinders were equally distributed across refrigerant technician businesses under the assumption that the size of the business would not be relevant in the decision-making for a technician to choose to empty a cylinder directly. Distributing cylinders equally is a more conservative assumption as it assumes a larger number of cylinders are handled by small businesses than if cylinders were distributed proportional to sales.

Approach for Estimating the Economic Impact on Small Governments

This analysis also uses a model entity approach to estimate impacts on small school districts and small governments for the leak repair, leak inspection, and recordkeeping and reporting requirements for school buses and transit buses, respectively.[55]

In the United States, there are approximately 13,085[56] school districts with a total enrollment of 33.1 million students as of 2018 (Urban Institute Education Data Portal 2022) and 482,714 yellow school buses[57] (EPA 2023). There are approximately 57,006 public transit buses in the United States serving over 174 million people in 3,030 cities as of 2017 (GFOA N.d.). This analysis assumes that each school district utilizes school buses for student transportation, and each city utilizes transit buses for public transportation. Furthermore, although approximately 40% of school buses and 28% of transit buses are contracted, it is assumed that costs associated with the rulemaking would be passed down to the individual school districts and cities (APTA 2022). Therefore, this analysis assumes that every school district and city is potentially impacted by the rulemaking.

Model Facility and Small Government Cost Assumptions

To analyze and estimate the economic impact of the leak repair and inspection provisions on school and transit buses, school districts were grouped into ten groups based on enrollment and transit buses were grouped into thirteen groups based on population. For school districts, the average enrollment, population within the school district, and revenue for the associated local government of each school district were determined for each enrollment size. For cities, the average population and revenue for the associated local government of each city were determined for each population size. Of the ten school enrollment groups, four were defined as small government with an average population of 50,000 or less and represent 12,187 school districts. Of the thirteen city population groups, four were defined as a small government with populations less than 50,000 and represent 2,276 cities.

As noted above, there are approximately 482,714 yellow school buses in use in the United States across 13,085 school districts. Approximately 51% of students ride a school bus as their primary means of transportation (USAFacts 2022), which equates to an average of 34 students per school bus. With

[55] Approximately 90% of transit buses are assumed to be operated by transit agencies (APTA 2022).
[56] 56 school districts have an enrollment of 0 students and were therefore not included in this analysis.
[57] While federal law does not require school buses to be yellow, the National Highway Traffic Safety Administration (NHTSA) provides recommendations to states on transportation safety and operational aspects of school buses. Along with other matters and uniform identifying characteristics, NHTSA recommends that school buses be painted "National School Bus Glossy Yellow".

approximately 51,305 public-owned transit buses, about 5% of the total population utilizes bus transit (Census Bureau 2021), which equates to an average of 180 people per bus.

Table G-9 summarizes the average enrollment, population, revenue, and number of school buses per school district within the four small government enrollment groups and the average population, revenue, and number of transit buses per city within the four small government population groups.

Table G-9 – School District and City Government Population and Revenue by Enrollment and Population Size

Enrollment Group	Number of Districts	Average Enrollment per District	Average Population per District	Average Revenue per District	Average School Buses per District
School Buses					
0-500	5,524	235	1,875	$4,138,069	3
501-999	2,538	712	5,458	$11,246,957	10
1,000-4,999	3,726	2,244	17,058	$37,866,965	33
5,000-9,999	399[a]	6,930	52,355	$112,226,575	101
	Population Group	**Number of Cities**	**Average Population per City**	**Average Revenue per City**	**Average Transit Buses per City**
Transit Buses					
	10,000-19,999	1,235	14,128	$29,805,843	4
	20,000-29,999	542	24,465	$51,459,646	7
	30,000-39,999	314	34,642	$72,953,140	10
	40,000-49,999	185	44,702	$99,530,151	13

Bolded rows represent a small government school district.

Source: Urban Institute Education Data Portal (2022) and Government Finance Officers Association (n.d.).

a Approximately 59% of the school districts within the 5,000-9,999 enrollment group are below the small government threshold.

Based on the analysis outlined in Appendix A, 68,158 school buses with charge sizes greater than 15 pounds and 24,147 transit buses are anticipated to exceed the threshold leak rate in 2028, and both are assumed to experience the leak repair outcomes outlined in Table G-10. Total standard leak repairs are distributed to every school district and city in proportion to the number of buses each school district and city uses. Because there are significantly fewer extension and retrofit repairs than standard leak repairs, extension and retrofit repairs are distributed within each group based on total number of buses within each group such that some districts and cities within each enrollment and population size will experience extension and/or retrofit repairs. This analysis therefore assumes that every school district and city experiences at least one standard leak repair, but not every school district and city is assumed to experience an extension or retrofit repair.

Table G-10 – Leak Repair Outcomes per School District or City

Enrollment Group	**School Districts**	**Average School Buses per District**	**Total School Buses per Enrollment Group**	**Standard Repairs per School District**	**Extension Repair per Enrollment Group**	**Retrofit Repair per Enrollment Group**
School Buses						
0-500	5,524	3	16,572	1	20	23
501-999	2,538	10	25,380	1	30	35
1,000-4,999	3,726	33	122,958	4	147	168
5,000-9,999	399	101	40,299	14	48	55
Population Group	**Cities**	**Average Transit Buses per City**	**Total Transit Buses per Population Group**	**Standard Repairs per City**	**Extension Repair per City**	**Retrofit Repair per City**
Transit Buses						
10,000-19,999	1,235	4	4,940	2	20	23
20,000-29,999	542	7	3,794	3	15	17
30,000-39,999	314	10	3,140	4	13	14
40,000-49,999	185	13	2,405	6	10	11

To estimate the economic impact of the leak repair and inspection provisions on school buses, four model government scenarios were established to represent various combinations of leak repair outcomes for each school district: standard repair only, standard repair + extension repair, standard repair + retrofit repair, and standard repair + extension repair + retrofit repair.

The four model governments are established based on the lowest number of repair type instances (in this case, extension repairs). It was therefore assumed that 50% of extension and retrofit repairs are experienced by a school district and city in addition to the assumed standard repair(s) for each group (i.e., standard repair + extension repair or standard repair + retrofit) and 50% of extension and retrofit repairs are experienced together by a school district and city in addition to the assumed standard repair(s) for each group (i.e., standard leak repair + extension repair + retrofit repair). The number of school districts and cities affected by each leak repair scenario is summarized in Table G-11.

Table G-11 – Number of School Districts and Cities Affected by Leak Repair Scenarios

Enrollment Group	School Districts	Average School Buses per District	Number of School Districts Impacted			
			Standard Repair Only	Standard + Extension Repair	Standard + Retrofit Repair	Standard + Extension + Retrofit Repair
School Buses						
0-500	5,524	3	5,491	10	13	10
501-999	2,538	10	2,488	15	20	15
1,000-4,999	3,726	33	3,485	74	95	74
5,000-9,999	399	101	320	24	31	24
Population Group	**Cities**	**Average Transit Buses per City**	**Number of Cities Impacted**			
			Standard Repair Only	**Standard + Extension Repair**	**Standard + Retrofit Repair**	**Standard + Extension + Retrofit Repair**
Transit Buses						
10,000-19,999	1,235	4	1,204	10	13	10
20,000-29,999	542	7	518	8	10	8
30,000-39,999	314	10	294	7	8	7
40,000-49,999	185	13	169	5	6	5

Cost estimates for each leak repair scenario were applied to each school district and city to evaluate the burden compared to their average revenue (see Appendix A for discussion of leak repair, leak inspection, and reporting and recordkeeping cost estimates).

Decision Matrix for Determining Significant Economic Impact on a Substantial Number of Small Entities

This analysis uses the matrix shown in Table G-12 to determine whether this rulemaking would impose a SISNOSE. The economic threshold levels are set conservatively at 1% and 3% of sales, consistent with similar analyses of other Clean Air Act Title VI rules. These thresholds are set conservatively because the rulemaking affects small businesses in a range of different industries, which may have significantly different profit margins and abilities to pass compliance costs along to customers, and a range of small governments with significantly different revenue. Based on this decision matrix, this screening analysis finds that the rulemaking can be presumed to have **no SISNOSE**.

Table G-12 – Decision Matrix for Certifying SISNOSE

Economic Impact	Number of Small Entities Subject to the Rule and Experiencing Given Economic Impact	Percent of All Small Entities Subject to the Rule That Are Experiencing Given Economic Impact	Certification Category
Less than 1% for all affected small entities	Any number	Any percent	Presumed No SISNOSE
1% or more for one or more affected small entities	Fewer than 100	Less than 20%	Presumed No SISNOSE
	Fewer than 100	20% or more	Uncertain – No Presumption
	Between 100 and 999	Less than 20%	Presumed No SISNOSE
	Between 100 and 999	20% or more	Uncertain – No Presumption
	1000 or more	Any percent	Uncertain – No Presumption
Greater than 3% for one or more affected small entities	Fewer than 100	Less than 20%	Presumed No SISNOSE
	Fewer than 100	20% or more	Uncertain – No Presumption
	Between 100 and 999	Less than 20%	Uncertain – No Presumption
	Between 100 and 999	20% or more	Presumed Ineligible for Certification
	1000 or more	Any percent	Presumed Ineligible for Certification

Aggregate Small Entities Impacts of Regulatory Changes

As shown in Table G-13, an estimated 753,105 small businesses and 14,463 small governments may be subject to the regulatory actions.

Table G-13 – Summary of the Small Entities Impact

Entity	Estimated Number of Small Entities Affected by the Rule
Small Business Industry Type	
Accommodations	8,522
Agriculture and Crop Support Services	3,015
Arts, Entertainment, and Recreation	183
Beverage and Ice Manufacturing	424
Charter Bus Industry	920
Disposal and Recycling Facilities	1,541
Durable Goods Wholesalers and Dealers	867

Entity	Estimated Number of Small Entities Affected by the Rule
Educational Services	175
Electronics Manufacturing	1,563
Fire Suppression Manufacturers	8
Fitness and Recreational Sports	387
Food manufacturing	3,788
Grocery and Specialty Food Stores	48,556
Hospitals	354
Materials Recovery Facilities (Reclaimers)	32
Non-durable Goods Wholesalers and Dealers	2,364
Non-food Manufacturing	43,271
Office Buildings	9,594
Other Chemical and Allied Products Merchant Wholesalers	2,755
Other Warehousing, Storage, and Transportation	50,882
Petrochemical Manufacturing	6
Refrigerant Technicians	49,964
Refrigerated Warehousing and Storage	399
Refrigeration Equipment and Supplies Merchant Wholesalers	280
Restaurants and Food Services	488,180
Support Activities for Transportation	218
Telecommunications and Information Services	29,695
Utilities	4,146
Warm Air Heating and Air-Conditioning Equipment and Supplies Merchant Wholesalers	1,017
Small Government Type	
School Districts	12,187
City Government	2,276
Total	**767,568**

Totals may not sum due to independent rounding.

To analyze the economic impacts on small entities against the SISNOSE decision matrix, a "sales test" was applied, which calculates annualized compliance costs as a percentage of annual sales for businesses in each NAICS code by size category and annual revenue for governments. Total economic impact includes incremental compliance costs for leak repair and inspection and ALD installation, as well as compliance costs for reporting and recordkeeping. For industries for which annual sales data were not available through the Economic Census, annual receipts or annual value of shipments[58] was used as a proxy.

Table G-14 aggregates the estimated economic impacts on small entities, according to the categories set out in the SISNOSE decision matrix and using a 3% discount rate. Using the decision criteria established in Table G-14, this screening analysis suggests that this rulemaking can be presumed to have no SISNOSE for the following reasons:

- About 75,167 small entities (9.8%) are not expected to incur compliance costs.
- About 691,866 small entities (90.1%) are estimated to incur compliance costs that will be less than 1% of annual sales/revenue.
- About 493 of the approximately 767,568 affected small entities (<0.06%) could incur costs in excess of 1% of annual sales/revenue. Approximately 12 small entities (<0.002%) could incur costs in excess of 3% of annual sales/revenue. These estimates are below the thresholds for a substantial number determination (i.e., between 100 and 999 entities and less than 20% of affected entities).

Table G-14 – Aggregated Economic Impacts on Small Entities with 3% Discount Rate

Economic Impact	Entity Type	Number of Small Entities Subject to the Rule and Experiencing Given Economic Impact	Percent of All Small Entities Subject to the Rule
Less than 1% for all affected small entities [a]	Accommodations	8,522	
	Agriculture and Crop Support Services	3,008	
	Arts, Entertainment, and Recreation	181	
	Beverage & Ice Manufacturing	417	
	Charter Bus Industry	83	
	City Government	2,276	

[58] Total value of shipments includes the received or receivable net selling values of all products shipped (excluding freight and taxes).

Economic Impact	Entity Type	Number of Small Entities Subject to the Rule and Experiencing Given Economic Impact	Percent of All Small Entities Subject to the Rule
	Disposal and Recycling Facilities	1,541	
	Durable Goods Wholesalers and Dealers	230	
	Educational Services	163	
	Electronics Manufacturing	1,563	
	Fire Suppression Manufacturers	8	
	Fitness and Recreational Sports	35	
	Food Manufacturing	2,130	
	Grocery & Specialty Food Stores	48,338	
	Hospitals	354	
	Materials Recovery Facilities (Reclaimers)	32	
	Non-durable Goods Wholesalers and Dealers	2,327	
	Non-Food Manufacturing	20,462	
	Office Buildings	1,778	
	Other Chemical and Allied Products Merchant Wholesalers	2,030	
	Other Warehousing, Storage, and Transportation	13,721	
	Petrochemical Manufacturing	6	
	Refrigerant Technicians	49,964	

Economic Impact	Entity Type	Number of Small Entities Subject to the Rule and Experiencing Given Economic Impact	Percent of All Small Entities Subject to the Rule
	Refrigerated Warehousing and Storage	397	
	Refrigeration Equipment and Supplies Merchant Wholesalers	238	
	Restaurants and Food Services	488,180	
	School Districts	12,187	
	Support Activities for Transportation	218	
	Telecommunications and Information Services	29,695	
	Utilities	1,226	
	Warm Air Heating and Air-Conditioning Equipment and Supplies Merchant Wholesalers	597	
	Total	**691,908**	**90.1%**
1% or more for one or more affected small entities [b]	Agriculture and Crop Support Services	7	
	Arts, Entertainment, and Recreation	<5	
	Beverage & Ice Manufacturing	7	
	Charter Bus Industry	<5	
	Durable Goods	7	
	Educational Services	12	

Economic Impact	Entity Type	Number of Small Entities Subject to the Rule and Experiencing Given Economic Impact	Percent of All Small Entities Subject to the Rule
	Food manufacturing	49	
	Grocery & Specialty Food Stores	217	
	Non-durable Goods	37	
	Non-food Manufacturing	72	
	Office Buildings	17	
	Other Warehousing, Storage, and Transportation	38	
	Refrigerated Warehousing and Storage	<5	
	Utilities	25	
	Total	**493**	**0.06%**
3% or more for one or more affected small entities [b]	Durable Goods	<5	
	Non-durable Goods	<5	
	Office Buildings	<5	
	Utilities	9	
	Total	**12**	**<0.01%**

Totals may not sum due to independent rounding.

[a] Represents small entities affected with an economic impact equal to or less than 1% but greater than 0%. Approximately 75,209 affected small businesses—or 9.8 percent—would be expected to experience negligible to net positive (i.e., cost-saving) impacts.

[b] This category aggregates the number of small entities that would be expected to experience an impact of 1% to 3% with the number of small entities that would be expected to experience an impact of 3% or greater.

Additional References

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Appendix H. Industries Affected by This Rule

Table H-1 – NAICS Classifications of Potentially Affected Entities

NAICS Code	NAICS Industry Description
236118	Residential Remodelers
236220	Commercial and Institutional Building Construction
238220	Plumbing, Heating, and Air-Conditioning Contractors
238990	All Other Specialty Trade Contractors
311812	Commercial Bakeries
321999	All Other Miscellaneous Wood Product Manufacturing
322299	All Other Converted Paper Product Manufacturing
324191	Petroleum Lubricating Oil and Grease Manufacturing
324199	All Other Petroleum and Coal Products Manufacturing
325199	All Other Basic Organic Chemical Manufacturing
325211	Plastics Material and Resin Manufacturing
325412	Pharmaceutical Preparation Manufacturing
325414	Biological Product (except Diagnostic) Manufacturing
325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing
326299	All Other Rubber Product Manufacturing
327999	All Other Miscellaneous Nonmetallic Mineral Product Manufacturing
332812	Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers
332999	All Other Miscellaneous Fabricated Metal Product Manufacturing
333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing
333511	Industrial Mold Manufacturing
333912	Air and Gas Compressor Manufacturing
333999	All Other Miscellaneous General Purpose Machinery Manufacturing
334413	Semiconductor and Related Device Manufacturing
334419	Other Electronic Component Manufacturing

NAICS Code	NAICS Industry Description
334516	Analytical Laboratory Instrument Manufacturing
335220	Major Household Appliance Manufacturing
336120	Heavy Duty Truck Manufacturing
336212	Truck Trailer Manufacturing
336214	Travel Trailer and Camper Manufacturing
3363	Motor Vehicle Parts Manufacturing
3364	Aerospace Product and Parts Manufacturing
336411	Aircraft Manufacturing
336611	Ship Building and Repairing
336612	Boat Building
339112	Surgical and Medical Instrument Manufacturing
339113	Surgical Appliance and Supplies Manufacturing
339999	All Other Miscellaneous Manufacturing
423120	Motor Vehicle Supplies and New Parts Merchant Wholesalers
423450	Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers
423610	Electrical Apparatus and Equipment, Wiring Supplies, and Related Equipment Merchant Wholesalers
423620	Household Appliances, Electric Housewares, and Consumer Electronics Merchant Wholesalers
423690	Other Electronic Parts and Equipment Merchant Wholesalers
423720	Plumbing and Heating Equipment and Supplies (Hydronics) Merchant Wholesalers
423730	Warm Air Heating and Air-Conditioning Equipment and Supplies Merchant Wholesalers
423740	Refrigeration Equipment and Supplies Merchant Wholesalers
423830	Industrial Machinery and Equipment Merchant Wholesalers
423840	Industrial Supplies Merchant Wholesalers
423850	Service Establishment Equipment and Supplies Merchant Wholesalers
423860	Transportation Equipment and Supplies (except Motor Vehicle) Merchant Wholesalers
423990	Other Miscellaneous Durable Goods Merchant Wholesalers
424690	Other Chemical and Allied Products Merchant Wholesalers

NAICS Code	NAICS Industry Description
424820	Wine and Distilled Alcoholic Beverage Merchant Wholesalers
441310	Automotive Parts and Accessories Stores
443141	Household Appliance Stores
444190	Other Building Material Dealers
445110	Supermarkets and Other Grocery (except Convenience) Stores
445131	Convenience Retailers
445298	All Other Specialty Food Retailers
446191	Food (Health) Supplement Stores
449210	Electronics and Appliance Retailers
452311	Warehouse Clubs and Supercenters
453998	All Other Miscellaneous Store Retailers (except Tobacco Stores)
45711	Gasoline Stations With Convenience Stores
481111	Scheduled Passenger Air Transportation
488510	Freight Transportation Arrangement
493110	General Warehousing and Storage
531120	Lessors of Nonresidential Buildings (except Mini warehouses)
541330	Engineering Services
541380	Testing Laboratories
541512	Computer Systems Design Services
541519	Other Computer Related Services
541620	Environmental Consulting Services
561210	Facilities Support Services
561910	Packaging and Labeling Services
561990	All Other Support Services
562111	Solid Waste Collection
562211	Hazardous Waste Treatment and Disposal
562920	Materials Recovery Facilities
621498	All Other Outpatient Care Centers

NAICS Code	NAICS Industry Description
621999	All Other Miscellaneous Ambulatory Health Care Services
72111	Hotels (Except Casino Hotels) and Motels
72112	Casino Hotels
72241	Drinking Places (Alcoholic Beverages)
722511	Full-service Restaurants
722513	Limited-Service Restaurants
722514	Cafeterias, Grill Buffets, and Buffets
722515	Snack and Nonalcoholic Beverage Bars
81119	Other Automotive Repair and Maintenance
811219	Other Electronic and Precision Equipment Repair and Maintenance
811412	Appliance Repair and Maintenance
922160	Fire Protection

Appendix I. Cost of Reclaim/Recycled HFCs Sensitivity Results

In the base case scenario, EPA assumed reclaimed/recycled HFCs to be 10% more expensive than virgin HFCs. This was chosen as a conservative measure to prevent underestimating the total cost. However, as pointed out by comments received under the Notice of Proposed Rulemaking (NPRM), the cost of reclaim may be closer to parity with virgin manufacture. Thus, EPA ran an additional analysis where reclaimed/recycled HFCs cost were equivalent to virgin HFCs. The results for this analysis are shown in Table I-1.

Table I-1 – Difference in annual incremental cost for all MAC options for different reclaim costs (millions of 2022$, discounted to 2024)[a,b,c]

<table>
<tr><th colspan="10">Cost of Reclaim
Sensitivity Analysis</th></tr>
<tr><th>Year</th><th colspan="3">Reclaim > Virgin (Base Case)</th><th colspan="3">Reclaim = Virgin</th><th colspan="3">% Change</th></tr>
<tr><td>2026</td><td colspan="3">$79.71</td><td colspan="3">$79.52</td><td colspan="3">-0.2%</td></tr>
<tr><td>2027</td><td colspan="3">$111.60</td><td colspan="3">$111.40</td><td colspan="3">-0.2%</td></tr>
<tr><td>2028</td><td colspan="3">$93.49</td><td colspan="3">$93.28</td><td colspan="3">-0.2%</td></tr>
<tr><td>2029</td><td colspan="3">$95.06</td><td colspan="3">$91.42</td><td colspan="3">-3.8%</td></tr>
<tr><td>2030</td><td colspan="3">$93.05</td><td colspan="3">$88.95</td><td colspan="3">-4.4%</td></tr>
<tr><td>2031</td><td colspan="3">$90.45</td><td colspan="3">$86.49</td><td colspan="3">-4.4%</td></tr>
<tr><td>2032</td><td colspan="3">$87.51</td><td colspan="3">$83.69</td><td colspan="3">-4.4%</td></tr>
<tr><td>2033</td><td colspan="3">$84.71</td><td colspan="3">$81.01</td><td colspan="3">-4.4%</td></tr>
<tr><td>2034</td><td colspan="3">$83.03</td><td colspan="3">$79.46</td><td colspan="3">-4.3%</td></tr>
<tr><td>2035</td><td colspan="3">$79.05</td><td colspan="3">$75.58</td><td colspan="3">-4.4%</td></tr>
<tr><td>2036</td><td colspan="3">$75.15</td><td colspan="3">$71.79</td><td colspan="3">-4.5%</td></tr>
<tr><td>2037</td><td colspan="3">$71.65</td><td colspan="3">$68.41</td><td colspan="3">-4.5%</td></tr>
<tr><td>2038</td><td colspan="3">$68.09</td><td colspan="3">$64.95</td><td colspan="3">-4.6%</td></tr>
<tr><td>2039</td><td colspan="3">$64.46</td><td colspan="3">$61.44</td><td colspan="3">-4.7%</td></tr>
<tr><td>2040</td><td colspan="3">$60.77</td><td colspan="3">$57.87</td><td colspan="3">-4.8%</td></tr>
<tr><td>2041</td><td colspan="3">$57.99</td><td colspan="3">$55.22</td><td colspan="3">-4.8%</td></tr>
<tr><td>2042</td><td colspan="3">$53.45</td><td colspan="3">$50.79</td><td colspan="3">-5.0%</td></tr>
<tr><td>2043</td><td colspan="3">$49.80</td><td colspan="3">$47.22</td><td colspan="3">-5.2%</td></tr>
<tr><td>2044</td><td colspan="3">$47.86</td><td colspan="3">$45.26</td><td colspan="3">-5.4%</td></tr>
<tr><td>2045</td><td colspan="3">$46.22</td><td colspan="3">$43.60</td><td colspan="3">-5.7%</td></tr>
<tr><td>2046</td><td colspan="3">$46.01</td><td colspan="3">$43.37</td><td colspan="3">-5.7%</td></tr>
<tr><td>2047</td><td colspan="3">$45.90</td><td colspan="3">$43.24</td><td colspan="3">-5.8%</td></tr>
<tr><td>2048</td><td colspan="3">$45.91</td><td colspan="3">$43.22</td><td colspan="3">-5.9%</td></tr>
<tr><td>2049</td><td colspan="3">$46.02</td><td colspan="3">$43.31</td><td colspan="3">-5.9%</td></tr>
<tr><td>2050</td><td colspan="3">$46.24</td><td colspan="3">$43.51</td><td colspan="3">-5.9%</td></tr>
<tr><td>DR</td><td>2%</td><td>3%</td><td>7%</td><td>2%</td><td>3%</td><td>7%</td><td>2%</td><td>3%</td><td>7%</td></tr>
</table>

PV	$1,343	$1,196	$790	$1,292	$1,151	$764	-3.8%	-3.7%	-3.4%
EAV	$68.80	$68.69	$67.80	$66.17	$66.13	$65.52	-3.8%	-3.7%	-3.4%

[a] The first scenario represents the base case which assumes a 10% markup on the cost of reclaim. The second scenario assumes the reclaim and virgin HFCs are equivalent in cost.
[b] Present values are calculated using end of year discounting.
[c] The equivalent annual values of benefits are calculated over a 25-year period.

When assuming reclaim parity with virgin, annual incremental costs fall by $0.11 M to $2.44 M (0% to 5% decrease). However, when compared to the total cost of the rule this represents only a marginal decrease of ~2%.

Appendix J. Alternative Equipment Age Requirements for ALD

The EPA considered different equipment age cutoffs for the ALD requirement in this rule beyond new CR and IPR refrigerant-containing appliances, which are required to install the ALD system within 30 days of installation. Additional analyses were with equipment age thresholds of 5 years and all existing equipment in addition to the base case (10 years before the January 1, 2027 compliance date). Results are summarized in Table J-1.

Table J-1 – Difference in annual incremental cost for all MAC options for different equipment age cutoffs for the ALD requirement (millions of 2022$, discounted to 2024)

Alternative Equipment Age Requirements for ALD Sensitivity Analysis					
	Cost (2022$)			***% Change from Base Case***	
Year	***2017+ (Base Case)***	***2021+***	***All Existing***	***2021+***	***All Existing***
2026	$80	$80	$80	0.0%	0.0%
2027	$112	$92	$148	-17.4%	32.9%
2028	$93	$84	$144	-9.6%	54.0%
2029	$95	$86	$142	-9.4%	49.8%
2030	$93	$84	$137	-9.6%	47.5%
2031	$90	$82	$131	-9.8%	45.4%
2032	$88	$79	$125	-10.1%	43.2%
2033	$85	$76	$119	-10.4%	40.7%
2034	$83	$73	$113	-11.8%	35.9%
2035	$79	$70	$106	-10.8%	34.5%
2036	$75	$68	$100	-9.9%	32.7%
2037	$72	$65	$94	-8.7%	30.5%
2038	$68	$63	$87	-7.4%	28.0%
2039	$64	$61	$81	-6.0%	25.2%
2040	$61	$57	$74	-6.3%	22.0%

2041	$58			$53			$67			-8.3%			16.2%		
2042	$53			$50			$61			-7.2%			13.9%		
2043	$50			$47			$56			-5.6%			11.7%		
2044	$48			$46			$53			-3.7%			10.5%		
2045	$46			$45			$51			-1.8%			9.5%		
2046	$46			$46			$50			0.0%			8.3%		
2047	$46			$46			$49			0.0%			7.4%		
2048	$46			$46			$49			0.0%			6.6%		
2049	$46			$46			$49			0.0%			6.0%		
2050	$46			$46			$49			0.0%			5.7%		
DR	**2%**	**3%**	**7%**	**2%**	**3%**	**7%**	**2%**	**3%**	**7%**	**2%**	**3%**	**7%**	**2%**	**3%**	**7%**
PV	$1,343	$1,196	$790	$1,235	$1,098	$721	$1,746	$1,563	$1,048	-8%	-18%	-46%	30%	16%	-22%
EAV	$69	$69	$68	$63	$63	$62	$89	$90	$90	-8%	-8%	-10%	30%	30%	31%

Appendix K. Disposable Cylinder Management

Introduction

Most HFCs, including those used as refrigerants, are gases at room temperature and are typically transported and stored as compressed liquids in pressurized metal containers called cylinders. There are two primary types of cylinders. Disposable (also known as non-refillable or single-use or DOT-39) cylinders are used once before disposal, whereas refillable cylinders can be used multiple times throughout the cylinder lifetime. Disposable cylinders today are typically discarded with refrigerants still in the cylinders, including from amounts commonly referred to as heels (i.e., the small amount of refrigerant that remains in an "empty" cylinder). These residual refrigerants are emitted over time as they leak out or are expelled when the cylinder is crushed for disposal or metal recycling. So-called "30-pound" metal cylinders are most often disposable but may come in refillable designs as well and are used primarily in the stationary air-conditioning and refrigeration system servicing industry and, to a lesser extent, in motor vehicle air conditioning.

The provisions of this rule include requirements to remove the heel from used disposable cylinders before the cylinders are discarded; the requirement covers disposable cylinders used for servicing, repair, disposal, or installation of equipment. Both disposable and refillable cylinders will be available for transporting refrigerant; however, it is expected that refillable cylinders are returned and refilled several times in the baseline, and that no additional costs or environmental impacts from refillable cylinders result based on this rule. For analytical purposes, the Agency focused on anticipated additional reductions in HFC consumption and emissions as well as industry costs and the potential savings from avoided refrigerant loss from disposable cylinders.

EPA has prepared a report, *Refrigerant Cylinders: Updated Analysis of Use, Disposal, and Distribution of Refrigerants* (EPA 2024a), analyzing the costs and environmental impacts of the requirement that disposable cylinders that have been used for the servicing, repair, or installation of refrigerant-containing equipment be transported to an EPA-certified reclaimer, and that reclaimers or another final processor within the supply and disposal chain remove all HFCs (i.e., heel) from disposable cylinders prior to discarding the cylinder. If the heel is removed by a final processor or otherwise in the supply chain, the removed heels may be consolidated, but must be sent to an EPA-certified reclaimer or fire suppressant recycler. This appendix presents a summary of some of the results from this report and provides further analysis.

Emission Estimates for Recovery of Disposable Cylinder Heels

The report assesses the typical distribution of refrigerants in cylinders, including refrigerant changes expected under the Base Case for this rule. Heels remaining in disposable cylinders were determined through both a theoretical and empirical study. Based on the wide range of disposal practices currently employed and expected to continue in absence of this final rule, three scenarios were developed to estimate the emissions avoided: a central scenario, a low scenario (i.e., a lower heel left in the cylinder), and a high scenario.

The emissions avoided by removing such heels are dependent on the number of disposable cylinders in circulation and the average heel that would otherwise be emitted in absence of this rule. Based on the report cited above, we assume in the central scenario that there are approximately 4.5 million cylinders in circulation, of which 99% are disposable. Further, we estimate that the average heel is approximately 4% by weight of the nominal capacity (e.g. 0.96 pounds for a 24-pound cylinder).[59] We use a heel of 0.288 pounds (1.2 percent) and 1.65 pounds (6.875 percent) for the low and high scenarios, respectively. Because of the other regulations in place, it is expected that the average GWP of the refrigerant in such cylinders will decrease. Other emissions associated with cylinders—for example, during transport and storage—are not expected to change based on this rule. Based on the expected transitions from these regulations, Table K-1, below, presents the avoided emissions for the years 2028 through 2050.

Table K-1 – Estimated Annual Emission Changes Compared with BAU, 2028–2050

Year	Average HFC GWP	Emission Reductions Relative to BAU ($MMTCO_2e$)		
		Central	Low	High
2028	1,547	2.27	0.68	3.90
2029	1,498	2.17	0.65	3.73
2030	1,445	2.06	0.62	3.54
2031	1,390	1.95	0.59	3.35
2032	1,332	1.84	0.55	3.17
2033	1,274	1.74	0.52	2.99
2034	1,210	1.63	0.49	2.80
2035	1,142	1.52	0.46	2.61
2036	1,071	1.41	0.42	2.42
2037	1,002	1.31	0.39	2.25
2038	945	1.22	0.37	2.10
2039	900	1.16	0.35	1.99
2040	872	1.12	0.33	1.92
2041	843	1.07	0.32	1.84

[59] R-404A is typically sold in a 24-pound cylinder. Cylinders for other HFC refrigerants are typically larger, from 25 to 50 pounds. We use 24 pounds as a conservative estimate here.

Year	*Average HFC GWP*	*Emission Reductions Relative to BAU (MMTCO2e)*		
		Central	*Low*	*High*
2042	814	1.03	0.31	1.77
2043	788	0.99	0.30	1.71
2044	769	0.97	0.29	1.66
2045	753	0.94	0.28	1.62
2046	742	0.93	0.28	1.60
2047	733	0.92	0.28	1.58
2048	726	0.91	0.27	1.56
2049	720	0.90	0.27	1.55
2050	717	0.90	0.27	1.54
Total		**30.96**	**9.29**	**53.21**

Cost Estimates for Recovery of Disposable Cylinder Heels

The report also assesses the cost implications for the requirement for heel removal, accounting for the costs associated with the change in procedure handling of cylinders (i.e., returning the cylinders for heels to be removed) and the potential savings from avoided refrigerant loss from heel emissions. There are multiple paths that the cylinder may take before the heel is removed and the truly-empty cylinder is landfilled or recycled. This analysis assumes that some cylinders will be: (a) sent directly to the reclaimer; (b) returned to a wholesaler or distributor,[60] who will ship disposable cylinders to a landfill or steel recycling facility, which would combine heels for shipment to a reclaimer; and (c) shipped directly from the end-user or technician to a landfill or steel recycling facility, which would combine heels for shipment to a reclaimer. For paths (b) and (c) above, we assume the landfill or steel recycling facility would reduce costs by combining 25 refrigerant heels (at 0.96 pounds as discussed above) of each HFC or HFC substitutes containing an HFC (e.g., HFC/HFO blends) they receive into individual 24-pound cylinders before sending those to a reclaimer. After recovering heels, reclaimers are assumed to send disposable cylinders to a landfill or steel recycler.

Neat HFOs, which are not regulated substances under this rulemaking but are used in some RACHP equipment, are not accounted for in the analysis. For HFCs and HFC/HFO blends, we divide cylinders equally amongst the transportation paths described above. Thus, we assume one-third follow path (a),

[60] Wholesalers and distributors could also perform the heel recovery, and likewise amass heels into a single cylinder to be shipped to a reclaimer. Based on comments to the NPRM that indicate an economic disincentive to doing that at a wholesaler/distributor facility, we assume cylinders with heels received by these entities are shipped directly to the landfill or steel recycler.

one-third follow path (b), and one-third follow patch (c). Table K-2 displays the estimated mileage for each leg of the paths taken compared to the business-as-usual (BAU) route.

Table K-2 – Estimated Distances for Disposable Cylinder Transportation Compared with BAU (Miles)[a]

Transportation Leg	***BAU***	***(a) End-user to Reclaimer to Landfill***	***(b) End-user to Distributor to Reclaimer***	***© End-user to Landfill***
Producer/Filler to Wholesale Distributor	1,000	1,000	1,000	1,000
Wholesale Distributor to End User/Technician	25	25	25	25
End User/Technical to Steel Recycler/Landfill	75	NA	NA	75
End User/Technical to Reclaimer	NA	50	NA	NA
End User/Technical to Wholesale Distributor	NA	NA	25	NA
Reclaimer to Steel Recycler/Landfill	NA	75	75	NA
Landfill sending Recovered Refrigerant to Reclaimer[b]	NA	NA	75	75
Total Miles per Cylinder	**1,100**	**1,150**	**1,128**	**1,103**

[a] CARB (2011)
[b] Each cylinder sent represents 25 cylinders received with heels (Central scenario).

The additional travel costs are influenced by how many cylinders fit on a truck, the fuel to drive the extra distances, and the incremental labor for such. By removing heels that would have otherwise been emitted, an additional supply is provided that would offset virgin production providing additional monetary benefits based on the cost of refrigerant. These assumptions are shown in Table K-3 below.

Table K-3 – Additional Disposable Cylinder Cost Assumptions

Factor (units)	***Value***	***Source***	***Notes***
Cylinders per Truck	1,120	CARB (2011)	
Average Truck Speed (miles per hour)	50	CARB (2011)	
Truck Transport Labor Rate ($/hour)	$53.59	U.S. Bureau of Labor Statistics (2023b)	May 2022 mean, including 110% overhead
Average Fuel Consumption (miles per gallon)	6.1	Geotab (2017)	Average across all states
Fuel cost ($/gallon)	$4.034	EIA (2024)	Price of diesel as of March 25, 2024
Cost of HFC refrigerant ($/pound)	$4		Consistent with past AIM Act analyses

Accounting for the fuel and labor associated with the additional shipment of cylinders and the cost of refrigerants, we estimate costs and monetary benefits, and hence the net savings, as shown in Table K-4 for the Central scenario.

Table K-4 – Costs, Monetary Benefits, and Net Savings of Cylinder Management (Central Scenario) (Millions 2022$)[a,b]

Year	Monetary Benefits			Costs			Net Savings		
2028	$12.94			$0.14			$12.80		
2029	$12.76			$0.14			$12.62		
2030	$12.57			$0.14			$12.43		
2031	$12.37			$0.13			$12.24		
2032	$12.19			$0.13			$12.06		
2033	$12.03			$0.13			$11.90		
2034	$11.88			$0.13			$11.75		
2035	$11.74			$0.13			$11.61		
2036	$11.62			$0.13			$11.49		
2037	$11.52			$0.13			$11.39		
2038	$11.43			$0.12			$11.30		
2039	$11.35			$0.12			$11.22		
2040	$11.28			$0.12			$11.16		
2041	$11.22			$0.12			$11.10		
2042	$11.16			$0.12			$11.04		
2043	$11.12			$0.12			$10.99		
2044	$11.09			$0.12			$10.97		
2045	$11.06			$0.12			$10.94		
2046	$11.05			$0.12			$10.93		
2047	$11.04			$0.12			$10.92		
2048	$11.03			$0.12			$10.91		
2049	$11.02			$0.12			$10.90		
2050	$11.02			$0.12			$10.90		
d.r.	2%	3%	7%	2%	3%	7%	2%	3%	7%
NPV	$197.1	$170.9	$101.9	$2.1	$1.9	$11	$194.9	$169.1	$100.8
EAV	$10.09	$9.82	$8.74	$0.11	$0.11	$0.095	$9.98	$9.71	$8.65

[b] Present values are calculated using end of year discounting.
[c] The equivalent annual values of benefits are calculated over a 25-year period.

Sensitivity Analyses for Recovery of Disposable Cylinder Heels

Several entities provided comments on the assumptions found in the report relied upon above (*e.g.*, Worthington, 2023). One commenter indicates the assumed number of cylinders of 4,500,000 is too low, that the heel remaining in a cylinder upon disposal of 4 percent is too high, and that the assumption that all or nearly all of such cylinders will emit the totality of the heel rather than be removed is not the case. Below we summarize the potential effects on the costs and emission reductions under alternate assumptions based on these comments.

The commenter says that their own sale of disposable cylinders is nearly 50% greater than EPA's estimate, that records indicate 3,941,577 cylinders were imported from China, and that other countries also supply an unspecified number of cylinders. Although it is not clear what percentage of these cylinders would be used for refrigerants covered by this rule, for this sensitivity analysis, we add to our central estimate a full 50% increase, plus the full number of reported cylinders from China, and we assume that the other countries contribute 1 million cylinders, for a total of 11,691,577 cylinders.

Comments also discussed the expected heel within a cylinder. One commenter indicated an estimated heel of 1.2 percent of the charged weight, while also citing various other estimates including 1.85 percent from CARB, noting this was also corroborated by the Heating, Air-conditioning and Refrigeration Distributers, International (HARDI), and 0.2 percent to 4.4 percent from Chemours, an HFC producer. Below we examine the lowest of these estimates, a 0.2 percent heel in lieu of our central estimate of 4 percent.

In addition, commenters took issue with the assumption that all cylinders will fully emit those heels. Instead, they argued that service technicians fully evacuate cylinders so that very little if any heel remains. The commenter above cited National Refrigerants, a reclaimer, stating that 90 percent of cylinders have a remaining heel of 0.5 pounds (about 2 percent) or less and that 60 percent have no discernible heel, an indication that cylinder heel removal is occurring in the field already. The commenter also pointed to CARB, which estimated that 70 percent of disposable cylinders are recycled or disposed without heel evacuation. The commenter held that it would be reasonable to assume between 10 percent and 70 percent are not properly evacuated before disposition. For this sensitivity analysis, we use the extreme conservative end of this range, i.e., 10 percent.

Table K-5 below presents the present value of the costs and the emissions avoided using the above discussed variables.

Table K-5 – Costs and Emission Reductions of Cylinder Management under Different Assumptions (Millions 2022$)

	Number of Cylinders	Heel	Not Vented	Savings; NPV in 2022$ (3% discount rate, discounted to 2024)	Emission Reductions ($MMTCO_2e$)
Central Scenario	4,500,000	4%	0%	$169.1 million	30.96
Higher Cylinders	11,691,577	4%	0%	$439.3 million	80.43
Lower Heel	4,500,000	0.2%	0%	$6.69 million	1.548
Low Vented	4,500,000	4%	90%	$16.91 million	3.096
Combined	11,691,577	0.2%	90%	$1.74 million	0.402

Regulatory Option

EPA proposed that requirements for disposable cylinder management begin in 2025. For reasons stated in the final rule, EPA has removed some of those requirements and delayed the date upon which they begin to January 1, 2028. The draft RIA Addendum included with the proposed rule examined the costs and environmental impacts of the proposed action. Table K-6 below provides the costs and emission reductions that would have been achieved under the finalized requirements with the proposed start date of 2025. The delay results in lower emission reductions and lower net savings for the final rule compared to an earlier effective date as proposed.

Table K-6 – Net Savings and Emission Reductions of Cylinder Management under Different Start Years ($MMTCO_2e$, Millions 2022$)

	Effective in 2028 (final rule)	Effective in 2025 (proposed rule)	Difference	Percentage change from proposed rule start date
Emission Reductions ($MMTCO_2e$)	30.96	38.49	-7.53	-19.6%
Net Savings[a] (millions 2022$)	$169.1	$205.3	-$36.2	-17.6%

[a]Net savings represent the present value at a 3% discount rate discounted to 2024.

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American Innovation and Manufacturing Act of 2020 – Subsection (h): Automatic Leak Detection Systems

Draft Technical Support Document
April 2024

Contents

Acronyms and Abbreviations

AIM Act	American Innovation and Manufacturing Act of 2020
ALD	Automatic Leak Detection
CAA	Clean Air Act
CARB	California Air Resources Board
CC	Comfort Cooling
CPUC	California Public Utilities Commission
CR	Commercial Refrigeration
EPA	Environmental Protection Agency
GHG	Greenhouse Gas
GWP	Global Warming Potential
HFC	Hydrofluorocarbon
ppm	Parts Per Million
RACHP	Refrigeration, Air Conditioning, and Heat Pumps
IPR	Industrial Process Refrigeration
$MTCO_2e$	Metric Tons of Carbon Dioxide Equivalent
O&M	Operation and Maintenance
RMP	Refrigerant Management Program
TSD	Technical Support Document

1. Introduction

Subsection (h) of the American Innovation and Manufacturing (AIM) Act of 2020, titled "Management of Regulated Substances," directs the U.S. Environmental Protection Agency (EPA) to establish certain regulations for regulated substances[1] and their substitutes for the purposes of maximizing reclaiming and minimizing releases of regulated substances (used interchangeably with hydrofluorocarbons (HFCs) in this document) from equipment and ensuring the safety of technicians and consumers.

More specifically, subsection (h) directs EPA to promulgate regulations to control, where appropriate, any practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment that involves: a regulated substance, a substitute for a regulated substance, the reclaiming of a regulated substance used as a refrigerant, or the reclaiming of a substitute for a regulated substance used as a refrigerant.

Subsection (h) also provides for the Agency to consider options to increase opportunities for reclaiming HFCs used as refrigerants and potential approaches to coordinate regulations carrying out subsection (h) of the AIM Act with other EPA regulations that involve the same or a similar practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment, or reclaiming.

As part of implementing subsection (h), EPA is finalizing certain regulatory requirements[2] regarding the use of automatic leak detection (ALD) systems. This Technical Support Document (TSD), prepared for the purposes of subsection (h), provides background information on ALD systems. Specifically:

- Section 2 provides background information on ALD technologies, including manufacturers, market presence, and data logging techniques.
- Section 3 provides information on the subsectors affected by the ALD system requirements.

2. Background

For purposes of this TSD, ALD systems on refrigerant-containing appliances are refrigerant leak detection technologies calibrated to continuously monitor a refrigerant-based system(s) for evidence of leaks and alert an operator upon detection of a leak. ALD systems detect leaks either directly or indirectly. Direct ALD systems use technology (e.g., sensors) that automatically detects the presence of refrigerant leaked into the air from a refrigerant-based system. An indirect ALD system automatically analyzes operating conditions (e.g., temperature, pressure) within a refrigerant-based system and identifies changes that indicate a refrigerant leak has occurred. Both types of ALD systems help to ensure early detection of leaks and help identify the location and severity of a leak.

[1] The AIM Act lists 18 saturated HFCs, and by reference any of their isomers not so listed, that are covered by the statute's provisions, referred to as "regulated substances" under the Act (42 U.S.C. 7675(c)(1)).
[2] See final rule in Docket EPA-HQ-OAR-2022-0606 at www.regulations.gov.

2.1 Direct ALD Systems

2.1.1 Technology Overview

Direct refrigerant leak detection technologies use sensors to monitor the concentration of refrigerants in the air. Direct ALD systems are fixed hardware that can be used on refrigerant-containing equipment and send an "alarm" to maintenance and/or operations staff if the user-specified leak level threshold (measured, for example, in parts per million (ppm)) is exceeded. Both active and passive sensors are available for direct ALD system technologies – both types offer the ability to connect to a building management system which can provide remote notification capabilities (Emerson, 2017). Active detectors use a central system with tubing that samples multiple areas. Passive sensors utilize zone-specific infrared technology, which can add to the cost if many passive sensors are used. Direct ALD system sensors should be located at all leak-prone components of a refrigeration system and positioned in a manner which minimizes disruptions in air flow; otherwise, some leaks may go undetected.

The benefits of direct ALD systems include being able to pinpoint the location and severity of a leak. Direct ALD systems can operate independent of refrigerant-based system controllers, which is another benefit for users that have older, malfunctioning, or out-of-calibration control systems. A potential drawback of direct ALD systems is that a sensor would typically need to be near the source of a leak, depending on the alert threshold setting, to trigger a leak alert, i.e., if the ppm threshold is set too high and/or too far from the sensor, the leak may be missed. Installing many sensors, or "zones," can alleviate this risk and provide comprehensive leak detection that can expedite repairs. However, additional sensors incur additional material and installation costs. Additionally, direct ALD systems are not intended for parts of a refrigerant-containing appliance that are not in an enclosed space (e.g., outside), since the sensors may not be able to pick up accurate readings given other potential sources of HFCs (e.g., other equipment that may be the source of the leak) and/or mixing with ambient air, which dilutes the reading.

Setting an appropriate leak level threshold, which triggers alerts to owners or operators, is important to detect leaks effectively. If a direct ALD system is installed with a leak level threshold that is too high, it is possible that only catastrophic leaks would be detected. On the other hand, if the leak level threshold is too low, the ALD system operation may result in false alarms. Existing leak repair programs, such as the California Air Resources Board (CARB) Refrigerant Management Program (RMP) and EPA Clean Air Act (CAA) Section 608, include guidance on the appropriate level of detection (i.e.,10 ppm) as well as the leak level threshold (i.e., 100 ppm) above which an alert is triggered. Installing and maintaining an ALD system with an appropriate leak level threshold setting could support accurate leak detection while avoiding expenditures on superfluous sensors.

2.1.2 Manufacturers and Market Presence

Information was gathered on direct ALD system manufacturers from manufacturers' websites, products offered by online wholesale suppliers, and sample data from market research reports on refrigerant gas leak detection systems. EPA reviewed annual reports from manufacturers, news articles, and case studies for this TSD to understand the current market supply of direct ALD systems; however, publicly available data on annual sales were not found. In a public comment on the proposed rule, a direct ALD systems manufacturer attested to the direct ALD systems market's ability to meet future demand (MSA, 2023). This manufacturer estimated that across their direct detection product portfolio and production locations, they alone have existing production volume levels and demonstrated capability of meeting the ALD system demand that would result from the proposed regulations. Therefore, there is a strong basis for EPA to determine that manufacturing can be scaled across the direct ALD systems industry to meet demand over time (MSA, 2023).

Many companies that manufacture direct refrigerant leak technologies manufacture handheld refrigerant leak detectors, but not fixed ALD systems. As such, it is important to distinguish between companies that manufacture direct refrigerant leak technologies generally from those that specifically manufacture fixed ALD systems. The companies identified below currently manufacture direct ALD systems for the U.S. market:

- Automated Logic
- CPS Products, Inc.
- Copeland (formerly Emerson Climate Technologies)
- MSA/Bacharach Inc.
- NevadaNano
- Parker Hannifin
- RC Systems
- Sentech
- Senva
- Thermal Gas Systems
- Toshiba
- TQ Environmental
- Trane

The majority of EPA-identified ALD system manufacturers sell direct ALD products. Direct ALD systems are a more established technology compared to indirect ALD systems, which are a more recently developed technology. Direct leak detection technologies can also be applied to more than just refrigerant gases (e.g., carbon monoxide), which expands the market for these products. EPA is not aware of publicly available sources to estimate the number of direct ALD systems currently installed in refrigerant-based systems in the United States.

2.2 Indirect ALD Systems

2.2.1 Technology Overview

Indirect ALD systems are a relatively newer technology than direct ALD systems and rely on predictive data analytics to detect leaks rather than physical detection of refrigerant gas. By gathering and identifying trends in data, indirect ALD systems monitor the operating conditions of a refrigerant-based system to infer whether a leak is present based on a deviation from "predicted" operating conditions. This method of leak detection is typically conducted using existing refrigerant-based system controllers and sensors that are already located on-site. An indirect ALD system is installed and connected to the controller(s) to record data and store it, often using cloud-based software. The technology then compares real-time operating conditions, such as liquid levels, pressures, temperatures, and ambient conditions, against historical trend data to determine if a leak may be occurring (Emerson, 2017). The system software can trigger leak alerts based on user settings. It is important that indirect ALD systems monitor multiple operating parameters to ensure accuracy in leak detection. Some older indirect ALD systems only use room temperature to determine whether a leak is present or not; newer indirect ALD systems often use multiple parameters working in tandem, such as temperature, pressure, liquid levels, etc., to help identify potential leaks (Axiom Cloud, 2023; CARB, 2023). Based on results from the CARB RMP, indirect ALD systems that rely on multiple data points are more accurate in identifying leaks, whereas systems utilizing only a single data point do not identify leaks as quickly or effectively (CARB, 2023).

Benefits of indirect ALD systems typically include the ability to monitor overall refrigeration system performance and identify potential maintenance issues that may otherwise go undetected until equipment fails and/or products spoil. Unlike a direct ALD system, the indirect ALD system is integrated into the refrigerant-based control system, so in addition to leaks, it is also monitoring for conditions such as high pressure. While most refrigerant-based controllers do this as well, the predictive analytics of an indirect ALD system may identify issues sooner than a controller alone would. Another benefit of indirect ALD systems is their ability to monitor all portions of a refrigerant-containing appliance, including portions of an appliance that are located outside of an enclosed space. Some indirect ALD systems can be utilized to monitor refrigeration system energy consumption and identify energy-saving measures as well (Hussmann Corporation, 2021). However, the features of an indirect ALD system beyond leak detection will vary by manufacturer/product.

A potential drawback of indirect ALD systems can be difficulty in locating a leak once it is identified. While these systems can identify leak events, the lack of physical gas sensors placed throughout a refrigerant-based system can make pinpointing individual leaks challenging and time-consuming. Once a leak event is identified, a service contractor or in-house technician would likely need to conduct a manual leak inspection of the entire refrigerant-based system using a handheld leak detector or bubble test. Another potential drawback of indirect ALD systems is that they rely on the existing refrigerant-based system controller and sensors. If the equipment is older, sensors may need to be recalibrated or replaced to ensure the accuracy of the leak detection methodology, which can be an additional expense. Regardless, when an indirect ALD system is installed, existing sensors and control systems should be checked to avoid false positives or negatives.

2.2.2 Manufacturers and Market Presence

Indirect ALD systems are an emerging technology. EPA is aware of four manufacturers with commercially available products in the United States – Axiom Cloud, Copeland (formerly Emerson Climate Technologies), Matalex, and Hussmann/Panasonic. Indirect ALD technologies have the potential to grow significantly in market share; because they are primarily a software-based system, indirect ALD systems can be deployed quickly and efficiently across many sites (Axiom Cloud, 2023).

In 2023, Axiom Cloud products were installed in 242 grocery stores and cold-storage facilities in the United States (NaturalRefrigerants.com, 2024). In a public comment on the proposed rule, Axiom Cloud expressed confidence in the indirect ALD market's ability to meet the anticipated demand, stating for example that their company's technology can be deployed to hundreds of facilities per week once access to corporate information technology systems is approved (Axiom Cloud, 2023).Matalex, another indirect ALD system manufacturer, has over 4,000 installations worldwide, and launched a pilot program in the United States in 2023 (Refrigeration Industry, 2023).

2.3 Data Logging and Reporting

The information generated and logged by ALD systems varies depending on the size and type of system. Smaller direct ALD systems (sometimes called "single-zone") are intended to monitor only one location (e.g., a mechanical room containing compressors) and may not generate information other than alerting users of the presence of increased refrigerant levels (Automated Logic, 2024). These smaller systems tend to be used in targeted areas to detect large leaks in real-time and may not have logging capabilities. Some smaller systems may log and store data on-site or remotely depending on the model and brand (Senva, 2024).

More extensive direct ALD systems may record and store refrigerant-based system operating pressures and temperatures, refrigerant concentrations at each sensor, as well as alarm and fault statuses in one or more locations (Copeland, 2024). Raw concentration data for leaked refrigerant may be adjusted based on factors, such as temperature, to adjust for a range of conditions and provide more accurate leak concentration data. Direct ALD systems may also provide historical trend data for a given location, displayed as a time series of concentration measurements. Both passive and active direct ALD system types generally offer the ability to connect to a building management system or refrigerant-based system controller which can provide remote leak notification capabilities (Emerson, 2017). Data may be sent to connected or centralized data displays. The quality of data collection for direct ALD systems also depends on the proper calibration and maintenance of devices. The collection and categorization of data may also depend on preset or user-determined refrigerant detection limits as well as thresholds for leak or evaluation levels (Copeland, 2024). Direct ALD systems are allowed under existing leak repair programs, such as the CARB RMP, and can be used as a compliance option in lieu of leak inspections under CAA Section 608, as long as they are calibrated and configured according to compliance requirements.

Inherent to indirect ALD system functionality is "predictive analytics;" therefore, all indirect systems log historical refrigerant-based system operational data to develop trend analytics that can be used to infer when a leak has occurred based on a deviation from "predicted" data. To acquire the necessary data, the hardware component of an indirect ALD system is connected to an existing refrigerant-based system controller on-site to collect data points being monitored by the controller. Such data can include receiver levels, pressures, temperatures, condenser heat rejection calculations, weather data, heat reclaim status, condenser split status, and other available data (Axiom Cloud, 2024). The data logged by the indirect ALD system are commonly stored in a cloud-based system. The data are accessible remotely to manufacturers and refrigerant-based system owners/operators, and leak alerts can be set up based on various parameters. Some indirect ALD systems can also produce reports that include a summary of prioritized leak events at a single location or multiple locations. While the specifics of indirect ALD system logging and reporting can be proprietary, these systems are allowed under existing leak repair programs, such as the CARB RMP, and can also be used as a compliance option in lieu of leak inspections under CAA section 608.

3. Subsector Characterizations Affected by ALD Requirements

3.1 Commercial Refrigeration

Commercial refrigeration systems are the refrigerant-containing appliances used in the retail food and cold storage warehouse subsectors. Retail food appliances include the refrigeration equipment found in supermarkets, restaurants, convenience stores, and other food service establishments. Cold storage includes the refrigeration equipment used to store meat, produce, dairy products, and other perishable goods.

Commercial refrigeration is the most common subsector where ALD systems are utilized. Food retail applications such as supermarket systems often contain distributed refrigeration equipment with extensive piping networks and many valves and connections. These systems can be extremely leak prone.

Current and anticipated federal and state requirements as well as partnership programs have incentivized the food retail sector to reduce refrigerant leak rates, and ALD systems have become one of the strategies used to reduce leaks (AHRI, 2022; EPA GreenChill, Hussmann Corporation, 2022). Of the commercially available direct and indirect ALD systems in the United States, all are marketed primarily towards the food retail sector for both supermarket systems and cold storage systems.

3.2 Industrial Process Refrigeration

Industrial process refrigeration (IPR) systems are complex, customized refrigerant-containing appliances that are directly linked to the processes used in, for example, the chemical, pharmaceutical, petrochemical, and manufacturing industries. IPR systems also include industrial ice machines, appliances used directly in the generation of electricity, and ice rinks. In some situations, one appliance may be used both for IPR and other applications.

IPR systems utilize ALD systems, but to a lesser extent than commercial refrigeration. IPR equipment often is configured as a packaged chiller containing refrigerant that is connected via a heat exchanger to a glycol loop that is distributed throughout the site. In this configuration, refrigerant is contained to a packaged piece of equipment, making refrigerant leaks less likely than in commercial refrigeration applications. When IPR systems use a direct exchange refrigeration system, carbon dioxide (CO_2) or ammonia (NH_3) are the most common refrigerants used. Ammonia systems have distinct requirements to prevent leaks and ensure human health and safety that are met by systems other than conventional ALD systems.

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Refrigerant Cylinders: Updated Analysis of Use, Disposal, and Distribution of Refrigerants

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Table of Contents

1. Introduction

Most hydrofluorocarbons (HFCs), including those used as refrigerants, are gases at room temperature and are typically transported and stored as compressed liquids in pressurized metal containers called cylinders. "30-pound" metal cylinders are used primarily in the stationary air-conditioning and refrigeration system servicing industry, and to a lesser extent in the motor vehicle air-conditioning (MVAC) sector.

There are two primary types of cylinders. Disposable (also known as non-refillable) cylinders are used once before disposal, and refillable cylinders can be used multiple times throughout the cylinder lifetime. Refrigerants can be emitted from non-refillable and refillable cylinders due to several conditions, including overfilling and subsequent exposure to excessive heat or blunt contact; mechanical damage to valves; valve defects; cylinder corrosion; and human error. However, non-refillable cylinders are typically discarded with amounts of refrigerants still in the cylinders that will be emitted over time including from amounts commonly referred to as heels (i.e., small amounts of refrigerant that remain in an "empty" cylinder)

The remainder of the report is organized as follows:

- **Section 2** provides an overview of non-refillable cylinders in the United States;
- **Section 3** provides estimates of disposal emissions from cylinders resulting from heels, and provides emissions savings estimates associated with refrigerant heel removal from non-refillable cylinders prior to disposal;
- **Section 4** analyzes the costs associated with refrigerant heel removal from non-refillable cylinders prior to disposal.
- **Section 5** provides conclusions;
- **Appendix A** provides the methodology used to calculate emissions from heels in non-refillable cylinders; and
- **Appendix B** estimates of annual emission changes from heel recovery from non-refillable cylinders.

2. Cylinders in the United States

The so-called "30-lb" cylinder[1] is the most commonly used cylinder for air-conditioning and refrigerant servicing and is the focus of this report. Both virgin and reclaimed refrigerant[2] can be transported and stored in refillable and non-refillable 30-pound cylinders. Based on input from industry sources, it is estimated that there are approximately four to five million 30-pound cylinders used to charge and service stationary air-conditioning and refrigeration systems annually in the United States, including both non-refillable and refillable cylinders (A-Gas, 2021; Fluorofusion, 2021), although estimates vary considerably. For the purposes of this report, it is

[1] The actual amount of refrigerant in a full "30-lb" cylinder varies by gas. Some typical values are 30 pounds (e.g., HFC-134a), 25 pounds (e.g., R-410A), and 24 pounds (e.g., R-404A).

[2] Refrigerant that is removed from equipment, however, is transported and stored in special recovery cylinders that are designed differently from non-refillable and refillable cylinders. Recovery cylinders are outside the scope of this analysis.

assumed that 4.5 million cylinders will be sold in the United States in 2025. Industry estimates that refillable cylinders currently account for between less than 1 percent and 10 percent of all 30-pound cylinders used, with a general assumption that the quantity of refillable cylinders as a percentage of all 30-pound cylinders used is closer to 1 percent as of 2020 (A-Gas, 2021; Fluorofusion, 2021; National Refrigerants, 2021). Of the 4.5 million cylinders assumed in use each year, this report specifically considers the proportion of cylinders sold containing HFC and blends containing HFCs versus other non-regulated substances such as hydrofluoroolefins (HFOs), as provided in Table 1. These estimates are based on HFC refrigerant demand for servicing and charging equipment estimated by EPA's Vintaging Model (EPA, 2023).[3]

Table 1. Assumed Refrigerant Mix in Non-refillable Cylinders (2025-2050)

Year	Percentage of Cylinders containing HFC and HFC blends
2025	79%
2026	78%
2027	77%
2028	76%
2029	75%
2030	73%
2031	72%
2032	71%
2033	70%
2034	69%
2035	69%
2036	68%
2037	67%
2038	67%
2039	66%
2040	66%
2041	66%
2042	65%
2043	65%
2044	65%
2045	65%
2046	65%

[3] As explained in the RIA to the Allocation Framework Rule and associated addenda to that RIA, the Vintaging Model estimates the consumption and emissions from end-uses that traditionally relied on ODS and are transitioning to HFCs and other alternatives. The EPA 2023 version of the model (VM IO file_v4.4_02.04.16_Final TT Rule 2023 High Addition.xls) incorporates the transitions and practices anticipated to occur under the 2023 Technology Transitions RIA Base Case, which in turn incorporates provisions of that rule and other actions anticipated under the 2024 Allocation Rule not otherwise adjusted based on the 2023 Technology Transitions Rule.

Year	Percentage of Cylinders containing HFC and HFC blends
2047	65%
2048	64%
2049	64%
2050	64%

Non-refillable cylinders are specifically manufactured to be single-use. These cylinders are charged with refrigerant, sold for use to fill or service equipment, and disposed (EIA, 2018). Many stationary air-conditioning and refrigeration systems are serviced using refrigerants transported in non-refillable cylinders that receive classification from the U.S. Department of Transportation (DOT) as DOT-39 cylinders. These cylinders come in several sizes, including 15-pound, 30-pound, and 50-pound varieties, with the 30-pound cylinder being the most commonly used in the stationary air-conditioning and refrigeration system servicing industry.

DOT-39 cylinders have a single one-way valve, and because of this feature, DOT prohibits the refilling of cylinders due to safety concerns.[4] They must be disposed of after use, either by recycling as scrap metal or disposed of as solid waste in a landfill. Non-refillable cylinder valves come with a rupture disk pressure relief device that allows the contents to be released when the pressure limits are exceeded. Once activated, this type of relief device ruptures and cannot reseal. If cylinders are disposed of improperly (i.e., without removing all refrigerant remaining in the cylinder), the residual refrigerant is emitted to the atmosphere. Table 2 summarizes the specifications for DOT-39 non-refillable cylinders.

Table 2. Specifications of "30-lb" DOT-39 non-refillable cylinder

	30-lb		
Service Pressure (psi)[a]	260	300	400
Test Pressure (psi)	325	400	500
Water Capacity (lb.)	29.7	29.7	29.7
Height (in)[b]	16.4	16.4	16.4
Diameter (in)[b]	9.5	9.5	9.5
Construction Standards	DOT39 TC39M	DOT39 TC39M	DOT39 TC39M

Source: Worthington n.d., 49 CFR 178,65 (i)
[a] Recommended service pressure is dependent on gas type
[b] Dimensions are assumed to be interior

As discussed above, for purposes of this analysis it is assumed that the vast majority of refrigerant cylinders sold annually in the United States (i.e., 99 percent) are non-refillable, or approximately 4.455 million cylinders. The remaining 45,000 cylinders (i.e., 1 percent) are assumed to be refillable.

[4] 49 CFR 178.65 (i)

3. Disposal Emissions from Cylinders

Emissions from all refrigerant cylinders can occur under various conditions. Refrigerant remaining in non-refillable cylinders, including amounts commonly referred to as refrigerant heels, are also emitted during disposal by leaking over time, once the cylinder breaks down, or when the cylinders are crushed. Service technicians will generally stop using a cylinder once all the liquid-phase fluid has been extracted while the vapor-phase gas remains as a heel. When a refillable cylinder is disposed, either from reaching end-of-life or due to damage to the cylinder, the heel would be emitted to the atmosphere unless it is removed.

3.1. Disposal of Non-refillable Cylinders

Non-refillable cylinders are not designed to be used reused and are prohibited from refilling under DOT regulations for safety concerns, and therefore they must be disposed of after they are used. If cylinders are disposed of without removing all remaining refrigerant including refrigerant heels, that refrigerant would be emitted to the atmosphere.

There is substantial uncertainty regarding the volume of refrigerant that remains in non-refillable cylinders at the point they are discarded including the amount in the heels. To better assess the emissions from non-refillable cylinders, it is necessary to estimate emissions associated with the common practice of disposing of cylinders with refrigerant heels (i.e., deemed to be "empty") by service technicians. A study by Stratus (2012) involved collecting empirical data on refrigerant remaining in cylinders collected after use in the field by service technicians for charging stationary refrigeration and air-conditioning systems. Based on the average heel amount found in the theoretical and empirical studies, an analysis of potential emissions from non-refillable cylinders under various recovery scenarios was also conducted (Stratus 2012).

3.1.1. Empirical study of heels

Stratus (2010a) collected data from a refrigerant technician company measuring quantities of refrigerant remaining in non-refillable cylinders after being used to service stationary air-conditioning and refrigeration equipment in the field. In this empirical study, the average amount of refrigerant remaining across all refrigerant types and applications was 1.08 lbs., with a range of 0.28 lbs. to 3.69 lbs. Stratus (2010a) indicated one reason why the amounts in the empirical study exceed theoretical estimates could be that often, a service technician will decline to take a cylinder "into the field" if he/she determines, simply by lifting the cylinder, that there is not enough refrigerant remaining in the cylinder to make transporting it worthwhile. Service technicians would prefer to have their service vehicle loaded with full cylinders at the beginning of the day to minimize the number of trips back to the vehicle that would be necessary when charging systems in the field.

3.1.2. Comparison of results to other studies

A comparison of the empirical studies by Stratus (2010a) shows that the results of this analysis are comparable to the results of other studies (see 3) and comments from industry stakeholders. A comparison of the empirical studies by Stratus (2010a) shows that the results of this analysis are comparable to the results of other studies (see Table 3) and comments from industry stakeholders. In a previous study of 30-pound non-refillable cylinders commissioned by EPA, the estimated heel amount after recovery to 29 psi was approximately 0.56 pounds (EPA 2007). Another study of amounts of refrigerant remaining in non-refillable cylinders conducted by a private company indicates an average amount of 0.59 pounds (approximately 2 percent) for 128 cylinders. In this study, cylinders containing HCFC-22 accounted for nearly 70 percent of all cylinders and had an average amount of 0.66 pounds. Cylinders containing R-404A, which accounted for approximately 25 percent of all cylinders, contained an average amount of 0.39 pounds. AHRI estimated that heel amounts in cylinders at system suction pressure (i.e., following use of cylinder for charging in the field) range from approximately 0.45 pounds (about 1.5 percent) to roughly 0.90 pounds (about 3 percent). These estimates were based on AHRI calculations (AHRI 2000). The amounts of refrigerant remaining in these studies is smaller than estimates from a 1998 study on heel amounts in 30-lb non-refillable cylinders conducted for Airgas Inc., which estimated heel amounts of approximately 1.65 lb (about 5.5%) across the industry (Airgas, 1998).

Table 3. Comparison of amount of refrigerant remaining from different sources

Source	Average Amount[a]	Amount by sector or use
Empirical study	1.08 lbs. (3.6 - 4.5%)	Appliance Servicing: 0.64 lbs. Residential AC: 1.02 lbs. Commercial AC: 1.13 lbs. Chillers: 1.15 lbs.
Private study[b]	0.59 lbs. (2.0 - 2.5%)	HCFC-22: 0.66 lbs. R-404A: 0.39 lbs.
EPA, 2007	0.56 lbs. (1.9 - 2.4%)	NA
Airgas, 1998	1.65 lbs. (5.5 - 6.9%)	NA
AHRI, 2000	0.45 lbs. (2%) - 0.90 lbs. (3%)	NA
Worthington, 2023	0.288 - 0.35 lbs. (1.2%)	
CARB and HARDI as cited by Worthington, 2023	0.444 - 0.555 lbs. (1.85%)	
Chemours, cited by Worthington, 2023	0.552 – 0.69 lbs. (2.3%)[c]	
National Refrigerants, cited by Worthington, 2023	0 - ≥0.5 lbs. (0 - 0.167%)[d]	

[a] Ranges are based on a 24 to 30 pound cylinder.
[b] Summary of study provided in Stratus (2010a)
[c] Cited as 0.2 percent to 4.4 percent; average used above.
[d] Cited as 60% with no discernible heel, 90% with 0.5 pounds or less; information on the remaining 10% not provided

Stratus (2010a) indicated potential causes for variation between the results of the different studies could be due to differing baseline assumptions and whether the study was theoretical or empirical. The results of an empirical study can vary depending on assumptions about operating conditions and the size of the sample. Theoretical studies can also produce varying results depending on assumptions about operating conditions (e.g., whether there are any assumed inefficiencies in the cylinder-to-system connection).

As shown in Table 3, estimates of the amount of refrigerant remaining in cylinders at the time of their disposal vary. Industry sources contacted by Stratus (2010a) confirmed the fact that there is uncertainty as to how much refrigerant remains in cylinders when they are determined to be "empty" and additional comment from industry stakeholders likewise show a variability in estimates of the heel. To determine a central estimate, we examine the complete records (i.e., all but the National Refrigerants information) cited above and find the average between the highest percentage heel (6.9%) and lowest percentage heel (1.2%) to be 4.05 percent. For mathematical simplicity and to be conservative, we use as a central estimate a 4% heel. Also being conservative, we assume cylinders are nominally 24 pounds. Hence, as a central estimate, we use a heel of 0.96 pounds.

Recent industry outreach, not used for the calculation above, estimates heels larger than the central estimate presented above. One such source indicated non-refillable cylinders contain approximately 1 to 1.25 pounds of residual heel and another source estimated the typical heel in a non-refillable cylinder is approximately 1.5 pounds (A-gas 2021, Fluorofusion 2021).

3.1.3. Avoided Emissions Under Different Refrigerant Removal Assumptions

Disposal emissions can be reduced by employing refrigerant recovery practices to minimize the heel. How service technicians dispose of used non-refillable cylinders will determine whether refrigerant that remains in the cylinder is released to the atmosphere or removed for reuse. To understand whether refrigerant remaining in cylinders is emitted to the atmosphere, it is important to know:

- When service technicians make the decision to switch to fresh cylinders;
- Whether service technicians remove the refrigerant remaining in the cylinders before they dispose of them;
- How (and to whom) service technicians dispose of the cylinders; and
- Whether there are downstream opportunities for refrigerant recovery after cylinders are no longer in the service technician's possession.

Disposal of non-refillable cylinders could present opportunities for downstream recovery (i.e., after the cylinder leaves the hands of the service technician). These practices have implications for avoiding the potential release of refrigerant remaining in the cylinders.

The prevalence of the different disposal practices is difficult to estimate. Input from industry sources varied considerably, and the majority of sources noted that there is no conclusive evidence about how service technicians dispose of cylinders. Several sources indicated that service technicians are aware of appropriate disposal methods (i.e., following AHRI guidelines for evacuating cylinders and opening their valves before having them recycled), but there seems to be less certainty on the issue of whether service technicians remove all refrigerant before recycling cylinders, or whether they allow the refrigerant to vent.

In the central scenario where the typical amount of refrigerant remaining is 0.96 pounds, estimated annual emissions can amount to between 0.27 $MMTCO_2e$ and 2.7 $MMTCO_2e$, depending upon the percentage of cylinders vented (see Appendix B). The assumed baseline for a central scenario is that 0.96 pounds of refrigerant remain in the cylinder that is vented unless recovered, and that 100 percent of all cylinders are vented (A-gas 2021, Fluorofusion 2021). Therefore, the assumed annual emissions in 2025 are 2.7 $MMTCO_2e$ and 0.9 $MMTCO_2e$ in 2050, based on the changing proportion of cylinders sold containing HFC and blends containing HFCs and mix of HFC refrigerants (see Appendix B).

3.2. Emission Reductions from Heel Removal from Cylinders

To understand the potential amount of emission avoided from heel recovery from non-refillable cylinders prior to disposal, the calculations were run using the assumption that 4.455 million 30-pound non-refillable cylinders are in use each year. Emissions from cylinder disposal were estimated assuming 0.96 pounds of refrigerant are remaining in the cylinders. The proportion of cylinders sold containing HFC and blends containing HFCs versus other non-regulated substances is assumed to change over time (see Table 1). In addition, it is assumed that the mixture of HFCs and blends containing HFCs also changes over time with the transitions and practices anticipated to occur under the 2024 Allocation Rule and the 2023 Technology Transitions Rule (EPA 2023). The assumed HFC refrigerant mix in 2025 is shown in Table 4.

Table 4. HFC Refrigerants in Cylinders, 2025

Refrigerant	Distribution of Cylinders
R-410A	32%
R-454B	21%
HFC-134a	11%
R-404A	11%
HFC-32	8%
R-407A	8%
R-450A/R-513A	3%
R-452B	3%
R-507	2%
R-452A	1%
R-407C	1%
R-448A/R-449A	0%
Total	**100%**

Source: EPA (2023)

This analysis also considers a low and high scenario under which cylinders are assumed to contain a refrigerant heel within the range of average heels as shown above in Table 3. The estimates therein lead us to a low scenario with an average heel of 0.288 pounds (1.2 percent of a 24-pound cylinder) and a high scenario with an average heel of 1.65 pounds (6.875 percent of a 24-pound cylinder).

The difference in emissions between the BAU scenario, where the heel is released upon disposal of non-refillable cylinders, and a scenario where all heels are removed before non-refillable are disposed is shown in Table 5. If heels were removed from non-refillable cylinders prior to disposal in the United States, 38.5 $MMTCO_2e$ in HFC emissions[5] would be avoided from 2025 through 2050. Annual emission reductions and the low and high scenario are presented in Appendix B.

Table 5. Estimated Total Avoided Emissions from Heel Recovery from Non-refillable Cylinders (2025-2050)

Scenario	Assumed Heel Amount Recovered (lbs.)	Pounds emitted	Metric tons emitted	$MMTCO_2e$
Low	0.288	26,433,000	11,990	11.5
Central	**0.96**	76,620,000	34,800	38.5
High	1.65	131,690,000	59,700	66.2

4. Cost Analysis of Heel Removal from Non-refillable Cylinders

Heel removal from non-refillable cylinders could have other implications for businesses in addition to emission savings. Estimating the economic impacts of heel removal from non-refillable cylinders must account for the costs associated with the change in procedure handling of cylinders (i.e., returning the cylinders to heels to be removed) and the potential savings from avoided refrigerant loss from heel emissions.

For the purposes of quantifying direct costs for this analysis, it was assumed that reclaimers, wholesalers, and distributors of refrigerant cylinders currently primarily sell refrigerant in non-refillable cylinders.

Cost of transport. In the business-as-usual scenario, non-refillable cylinders are assumed to travel from gas producer/filler to the wholesale distributor; wholesale distributor to end user/technician; and end user/technician to a disposal facility (e.g., landfill or steel recycler).

Transportation costs were updated to account for the distance traveled for each trip and the use of company fleets to transport cylinder based on a CARB (2011) analysis. It is assumed that companies already own or lease the proper vehicle fleet to transport cylinders.

Table 6 summarizes estimated distances per shipment for non-refillable cylinders. Based on the location of chemical production facilities around the United States, located primarily along the East Coast, Midwest, Southern United States, and California, it is assumed that a cylinder would travel an average of 1,000 miles from producer to the wholesale distributor. As assumed in CARB (2011), the distance between wholesale distributor and end-user/technician is assumed

[5] This estimate includes HFCs and blends containing HFCs and hydrofluoroolefins (HFOs).

to be 25 miles. Other distances—75 miles from an end-user or wholesaler to a steel recycler and 50 miles from a distributor to a reclaimer—were also based on CARB (2011).

In the heel removal scenario, it was assumed that non-refillable cylinders would take one of three potential transportation scenarios in equal shares: 1) cylinders would be returned directly to a reclaimer for heel removal; 2) cylinders would be returned to the distributor and then to a disposal facility for heel removal; or 3) cylinders would be sent directly to a disposal facility for heel removal. Upon removal of the heel, the disposal facility would store recovered refrigerant heels until the facility has accumulated enough refrigerant to send to a reclaimer. Based on a central estimate of a heel of 0.96 pounds, it is assumed that a disposal facility would remove refrigerant from 25 cylinders in order to accumulate enough to fill one 30-pound cylinder (i.e., 24 pounds of refrigerant).

Table 6. Travel Distances for Non-refillable Cylinders Before Disposal

Trip	BAU	Recovery Scenario				
		Non-refillable-1[a]	Non-refillable-2[a]		Non-refillable-3[a]	
		End-user to Reclaimer to Disposal Facility	End-user to Distributor to Disposal	Disposal Facility to Reclaimer	End-user to Disposal Facility	Disposal Facility to Reclaimer
Gas producer/filler to wholesale distributor	1,000	1,000	1,000	NA	1,000	NA
Wholesale distributor to end user/technician	25	25	25	NA	25	NA
End user/technician to disposal facility	75	NA	NA	NA	75	NA
End user/technician to reclaimer	NA	50	NA	NA	NA	NA
End user/technician to distributor	NA	NA	25	NA	NA	NA
Wholesale distributor or reclaimer to disposal facility	NA	75	75	NA	NA	NA
Disposal facility to Reclaimer	NA	NA	NA	75[b]	NA	75[b]
Total Miles	**1,100**	**1,150**	**1,125**	**75**	**1,110**	**75**

[a] Assumed for one-third of shipped HFC cylinders.
[b] Disposal facilities are assumed to recover refrigerant from 25 cylinders before sending one 30-lb cylinder (containing 24 pounds of refrigerant) to a reclaimer based on a 0.96-pound heel.

Table 7 provides additional assumptions related to fuel use and labor associated with transporting cylinders.

Table 7. Additional Transportation Assumptions

Parameter	Assumption
Average Fuel Efficiency	6.1 miles per gallon[a]
Diesel Fuel Cost	$4.034/gallon[b]
Average Truck Speed	50 miles per hour[c]
Labor Rate (Truck Transport)	$53.59[d]

[a] Geotab (2024)
[b] Energy Information Agency (2024)
[c] CARB (2011)
[d] Labor rate for Heavy and Tractor-Trailer Truck Drivers from Bureau of Labor Statistic's Employer Costs for Employee Compensation – May 2022. Median hourly wages rates were multiplied by a factor of 2.1 to reflect the estimated additional costs for overhead (BLS 2024).

Transportation costs were then calculated on a per cylinder basis. This analysis estimates transportation costs on a per cylinder basis assuming a truck could fit approximately 1,120 non-refillable cylinders (CARB 2011). Table 8 summarizes the transport cost per cylinder based on the assumptions presented above. Transportation costs are assumed to be the same under both the low and high scenarios.

Table 8. Transportation Assumptions before Disposal per Cylinder[a]

Scenario		Fuel Costs	Labor	Total
BAU	Non-refillable	$0.65	$1.05	$1.70
Recovery Scenario	Non-refillable-1 [b]	$0.68	$1.10	$1.78
	Non-refillable-2[b]	$0.66	$1.08	$1.75
	Non-refillable-2 (Disposal Facility)	$0.002	$0.003	$0.005
	Non-refillable-3[b]	$0.65	$1.05	$1.71
	Non-refillable-3 (Disposal Facility)	$0.002	$0.003	$0.005

[a] Costs are based on a recovered heel amount of 0.96 pounds and assumes disposal facilities recover refrigerant from 25 cylinders before sending one 30-lb cylinder (containing 24 pounds of refrigerant) to a reclaimer.
[b] Assumed for one-third of HFC cylinders sold per year.

Removed heel. Under the recovery scenario, non-refillable cylinders are eventually returned to a reclaimer prior to disposal containing a refrigerant heel that is removed and sold back into the market. It was assumed that cylinders contain a heel of 0.96 pounds as described above. Removed refrigerant is assumed to be resold at $4 per pound based on average refrigerant costs applied in EPA (2021a).

Under the low scenario, cylinders are assumed to contain a refrigerant heel of 0.288 pounds (1.2 percent) and under the high scenario, cylinders are assumed to contain a refrigerant heel of 1.675 pounds (6.875 percent).

Table 9 summarizes the cost assumptions associated with refrigerant heel removal from non-refillable cylinders prior to disposal. Because the proportion of non-refillable cylinders changes per year as equipment is assumed to transition towards lower-GWP substitutes, estimates are shown for 2025 for which the highest proportion of HFC cylinders are assumed in circulation, as shown in Table 1 (i.e., 79 percent); however costs are estimated throughout the 2025 to 2050 time period.

Table 9. Cost Assumptions for BAU and Central Estimate plus Low and High Scenario from Cylinder Heel Recovery, 2025

Assumption	BAU	Central Estimate	Low Scenario	High Scenario
Number of Cylinders Disposed	3,530,028	3,530,028	3,530,028	3,530,028
Average Transport Cost per Cylinder	$1.70	$1.74	$1.74	$1.75
Cylinder Heel Amount (lbs.) and Percent of Cylinder	0.96 (4%) or 0.288(1.2%) or 1.65 (6.875%)	0.96 (4%)	0.288 (1.2%)	1.65 (6.875%)
Average Refrigerant Price ($/lbs.)	$4	$4	$4	$4

Using the methodology and additional assumptions described above, Table 10 presents estimates of the present value (PV) of incremental costs associated with cylinder heel removal under the central scenario over the 26-year period 2025 to 2050, in addition to the low and high scenario assumptions. Annual incremental costs were discounted to 2024 at 2 percent, 3 percent and 7 percent discount rates (as directed by OMB's Circular A-4. Using a 3 percent discount rate, total savings across affected businesses are estimated to be $205 million.

Table 10. Summary of Incremental PV Costs of Cylinder Heel Recovery for 2025-2050 (Millions of 2022$, Discounted to 2024)

Discount Rate	Central	Low	High
2%	**-$232**	**-$68**	**-$401**
3%	**-$205**	**-$60**	**-$354**
7%	-$133	-$39	-$230

Table 11presents detailed cost estimates for each scenario using a 3% discount rate.

Table 11. Detailed Incremental PV Costs of Cylinder Heel Recovery for 2025-2050 (millions of 2022$, discounted to 2024, 3%)

Cost	Central	Low	High
Transportation	$2.26	$2.14	$2.37
Recovered Refrigerant Heel	-$208	-$62	-$357

5. Conclusion

Refrigerant losses can occur from non-refillable cylinders during disposal if unrecovered refrigerant is released. The amount of refrigerant heel remaining in cylinders can vary by refrigerant type and recovery practices by servicing technicians but is estimated to be approximately 0.96 pounds of refrigerant per cylinder. Disposal emissions from non-refillable can therefore equal 2,660,000 $MTCO_2e$ in 2025, assuming the heel is completely released from 100 percent of the cylinders. This amount would be expected to decrease as refrigerant transitions take place. The removal of refrigerant heels in non-refillable cylinders prior to their disposal in the United States would therefore be estimated to save approximately 38,500,000 $MTCO_2e$ from 2025 through 2050 in emissions.

There are other implications associated with the removal of refrigerant heels, including potentially higher costs associated with transporting cylinders back to reclaimers for refrigerant removal; however there are also cost savings associated with removing and reselling the refrigerant heel.

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Appendix A. Estimate of Emissions from Heels in Non-refillable Cylinders

Stratus (2010a) collected data by measuring quantities of refrigerant remaining in non-refillable cylinders after being used to service stationary air-conditioning and refrigeration equipment in the field. A refrigerant recovery, measurement, and recording framework was designed to facilitate collection and analysis of the data obtained with a Phoenix, Arizona refrigerant distributor. This section describes the methodology employed for collecting the data and the results produced.

Methodology

A sample of 30-pound non-refillable cylinders was collected by the Phoenix distribution company from service technicians who used the cylinders for various applications (i.e., servicing of residential air conditioners, appliances, commercial refrigeration systems, and chillers). The amounts of refrigerant remaining in the cylinders were measured, recorded, and analyzed. The cylinders were subjected to a recording and testing process that involved identifying the application for which the cylinder was used and the type of refrigerant it contained and measuring the amounts of refrigerant remaining by weighing the cylinders when they were obtained after use in the field.

Results

For this study, 110 30-pound non-refillable cylinders were collected and evaluated over a two-month period. As they were collected, the cylinders were identified as having been used to service stationary equipment in four categories of applications:

- Residential air-conditioning (e.g., standard home roof/split systems);
- Chillers (e.g., industrial and mechanical uses);
- Appliances (e.g., refrigerators and air conditioners); and
- Commercial refrigeration (e.g., supermarket refrigeration systems).

Many service technicians might service systems in only one of these applications, but some might service systems across multiple applications. The term "refrigerant remaining" is used in this section of the report. Due to the constraints of the cylinder collection component of the empirical study, it was not possible to determine whether the refrigerant remaining in the cylinder meets the regulatory definition of a heel (as defined in 40 CFR 82.3).

The cylinders collected for this study contained the following refrigerants: HCFC-22, R-404A, R-408A, R-410A, and R-507. Table A-1 provides the distribution of the cylinders by refrigerant type and application.

Table A- 1. Summary of cylinders collected by refrigerant and application

Application	HCFC-22 30 lb cylinder	R-404A 24 lb cylinder	R-408A 24 lb cylinder	R-410A 25 lb cylinder	R-507 25 lb cylinder	Total
Appliance servicing	2	0	0	0	0	2
Residential A/C	32	0	0	0	0	32

Commercial refrigeration	24	12	0	2	5	43
Chillers	26	5	2	0	0	33
Total	**84**	**17**	**2**	**2**	**5**	**110**

Source: ARS 2009

For each cylinder collected, an initial pressure gauge reading was taken, and the cylinder's weight recorded. Refrigerant recovery equipment was then used to extract the refrigerant remaining in the cylinder by pulling a vacuum. For 47 (or 43 percent) of the 110 cylinders collected, there was no pressure in the cylinder, either because the cylinder valve was opened and the refrigerant remaining in the cylinder was vented or because the refrigerant had already been recovered. Of these 47 cylinders:

- The refrigerant remaining in the cylinder was recovered by the source for 16 cylinders (all contained HCFC-22);
- Twelve cylinders had no pressure, but the valves had been closed; and
- Nineteen cylinders had no pressure and the valves were open.

Of the latter two types, it is unknown whether refrigerant was recovered by the source or if the refrigerant was vented. Of the 63 cylinders that remained under pressure (i.e., had measurable amounts of refrigerant remaining), most contained HCFC-22 and came from the residential air-conditioning sector. Table A-2 provides a summary of cylinders with pressure by refrigerant and source.

Table A- 2. Summary of cylinders collected with pressure by refrigerant and application

Application	HCFC-22 30 lb cylinder	R-404A 24 lb cylinder	R-408A 24 lb cylinder	R-410A 25 lb cylinder	R-507 25 lb cylinder	Total
Appliance servicing	1	0	0	0	0	1
Residential A/C	28	0	0	0	0	28
Commercial refrigeration	7	8	0	2	2	19
Chillers	11	4	0	0	0	15
Total	**47**	**12**	**0**	**2**	**2**	**63**

Of the cylinders that remained under pressure, the amounts of refrigerant remaining varied, with a mean of 1.08 lbs. Table A-3 and Table A-4 provide summary statistics of the amounts by refrigerant and application.

Table A- 3. Mean and median amounts of refrigerant remaining (lbs.), by refrigerant

Refrigerant	Number of cylinders	Mean amount	Median amount	Standard deviation	Minimum	Maximum
HCFC-22	47	1.02	0.68	0.78	0.28	3.69
R-404A	12	1.40	0.96	0.91	0.42	2.91
R-408A	0	N/A	N/A	N/A	N/A	N/A
R-410A	2	0.96	0.96	0.09	0.89	1.02
R-507	2	0.53	0.53	0.03	0.51	0.55

Total	**63**	**1.08**	**0.70**	**0.79**	**0.28**	**3.69**

Table A- 4. Mean and median amounts of refrigerant remaining (lbs.), by application

Application	Number of cylinders	Mean amount	Median amount	Standard deviation	Minimum	Maximum
Appliance servicing	1	0.64	0.64	N/A	N/A	N/A
Residential A/C	28	1.02	0.68	0.80	0.28	3.69
Commercial refrigeration	19	1.13	0.87	0.78	0.33	2.91
Chillers	15	1.15	0.68	0.84	0.47	3.26
Total	**63**	**1.08**	**0.70**	**0.79**	**0.28**	**3.69**

Appendix B. Estimation of Annual Emission Changes from Heel Removal from Disposable Cylinders

The annual emission changes between the BAU scenario without heel removal from non-refillable cylinders prior to disposal and the central, low, and high scenarios with heel removal assuming cylinders contain a 0.96, 0.288, or 1.65-pound heel and the average refrigerant GWP applied reflecting the change in mixture of HFCs and HFC blends resulting from mitigation options applied in EPA (2023) are shown in Table B-1.

Table B- 1. Estimated Annual Emission Changes Compared to BAU, 2025-2050

Year	Average HFC GWP	Emission Changes Relative to BAU ($MMTCO_2e$)		
		Central	Low	High
2025	1,732	-2.66	-1.25	-4.58
2026	1,652	-2.49	-1.17	-4.28
2027	1,598	-2.38	-1.12	-4.09
2028	1,547	-2.27	-1.06	-3.90
2029	1,498	-2.17	-1.02	-3.73
2030	1,445	-2.06	-0.97	-3.54
2031	1,390	-1.95	-0.91	-3.35
2032	1,332	-1.84	-0.86	-3.17
2033	1,274	-1.74	-0.81	-2.99
2034	1,210	-1.63	-0.76	-2.80
2035	1,142	-1.52	-0.71	-2.61
2036	1,071	-1.41	-0.66	-2.42
2037	1,002	-1.31	-0.61	-2.25
2038	945	-1.22	-0.57	-2.10
2039	900	-1.16	-0.54	-1.99
2040	872	-1.12	-0.52	-1.92
2041	843	-1.07	-0.50	-1.84
2042	814	-1.03	-0.48	-1.77
2043	788	-0.99	-0.47	-1.71
2044	769	-0.97	-0.45	-1.66
2045	753	-0.94	-0.44	-1.62
2046	742	-0.93	-0.44	-1.60
2047	733	-0.92	-0.43	-1.58
2048	726	-0.91	-0.43	-1.56
2049	720	-0.90	-0.42	-1.55
2050	717	-0.90	-0.42	-1.54
Total		**-38.5**	**-18.0**	**-66.2**

Updated Report - Analysis of the U.S. Hydrofluorocarbon Reclamation Market: Stakeholders, Drivers, and Practices

April 2024

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List of Abbreviations and Acronyms

AHRI	Air-Conditioning, Heating, and Refrigeration Institute
AIM	American Innovation and Manufacturing Act of 2020
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
CAA	Clean Air Act
CARB	California Air Resources Board
CFC	Chlorofluorocarbon
CFR	Code of Federal Regulations
CO_2e	Carbon dioxide equivalent
DOE	Department of Ecology
EIA	Environmental Investigation Agency
eNGO	Environmental non-governmental organization
ER&R	Emissions Reduction and Reclamation
EPA	Environmental Protection Agency
GC	Gas chromatograph
GHG	Greenhouse gas
GWP	Global warming potential
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HFO	Hydrofluoroolefin
IGSD	Institute for Governance & Sustainable Development
IPR	Industrial process refrigeration
lbs	pounds
$MMTCO_2e$	Million metric tons of carbon dioxide equivalent
MVAC	Motor vehicle air conditioning
NODA	Notice of Data Availability
NRDC	Natural Resources Defense Council
NYSDEC	New York State Department of Environmental Conservation
ODP	Ozone depletion potential
ODS	Ozone-depleting substances
OEM	Original equipment manufacturer
PTAC	Packaged terminal air conditioner
PTHP	Packaged terminal heat pump
R4 Program	Refrigerant Recovery, Reclaim, and Reuse Requirements (CARB Program)
RACHP	Refrigeration, air conditioning, and heat pumps
RMP	Refrigerant management program
RRA	Refrigerant Reclaim Australia
TEAP	Technology and Economic Assessment Panel to the Montreal Protocol
U.S.	United States
VM	Vintaging Model
VRF	Variable refrigerant flow

Executive Summary

Background

Subsection (h) of the American Innovation and Manufacturing (AIM) Act of 2020, titled "Management of Regulated Substances," directs the United States (U.S.) Environmental Protection Agency (EPA) to establish certain regulations for regulated substances[1] and their substitutes for the purposes of maximizing reclaiming and minimizing releases of regulated substances (used interchangeably with hydrofluorocarbons (HFCs) in this document) from equipment and ensuring the safety of technicians and consumers.

More specifically, subsection (h) directs EPA to promulgate regulations to control, where appropriate, any practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment that involves: a regulated substance, a substitute for a regulated substance, the reclaiming of a regulated substance used as a refrigerant, or the reclaiming of a substitute for a regulated substance used as a refrigerant.

Subsection (h) also provides for the Agency to consider options to increase opportunities for reclaiming HFCs used as refrigerants and potential approaches to coordinate regulations carrying out subsection (h) of the AIM Act with other EPA regulations that involve the same or a similar practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment, or reclaiming.

As part of implementing subsection (h), EPA is finalizing certain regulatory requirements[2] related to maximizing reclamation of regulated substances. This document, prepared for the purposes of subsection (h), provides background information on the refrigerant reclamation market in the United States and use of HFCs in the refrigeration, air conditioning, and heat pumps (RACHP) sector.

Report Contents and Organization

This report summarizes available information on the reclamation of refrigerants, including information on the processes and methods used, the stakeholders involved, and the key barriers to increasing refrigerant reclamation in the United States. The report is organized as follows:

- Section 1 provides an introduction and context of the AIM Act and reclamation.
- Section 2 provides background information on reclamation and EPA's regulatory authority over refrigerant reclamation as well as information on state actions pertaining to reclamation.
- Section 3 identifies key stakeholders in the reclamation industry and describes their roles and responsibilities.

[1] The AIM Act lists 18 saturated HFCs, and by reference any of their isomers not so listed, that are covered by the statute's provisions, referred to as "regulated substances" under the Act (42 U.S.C. 7675(c)(1)).
[2] See final rule in Docket EPA-HQ-OAR-2022-0606 at www.regulations.gov.

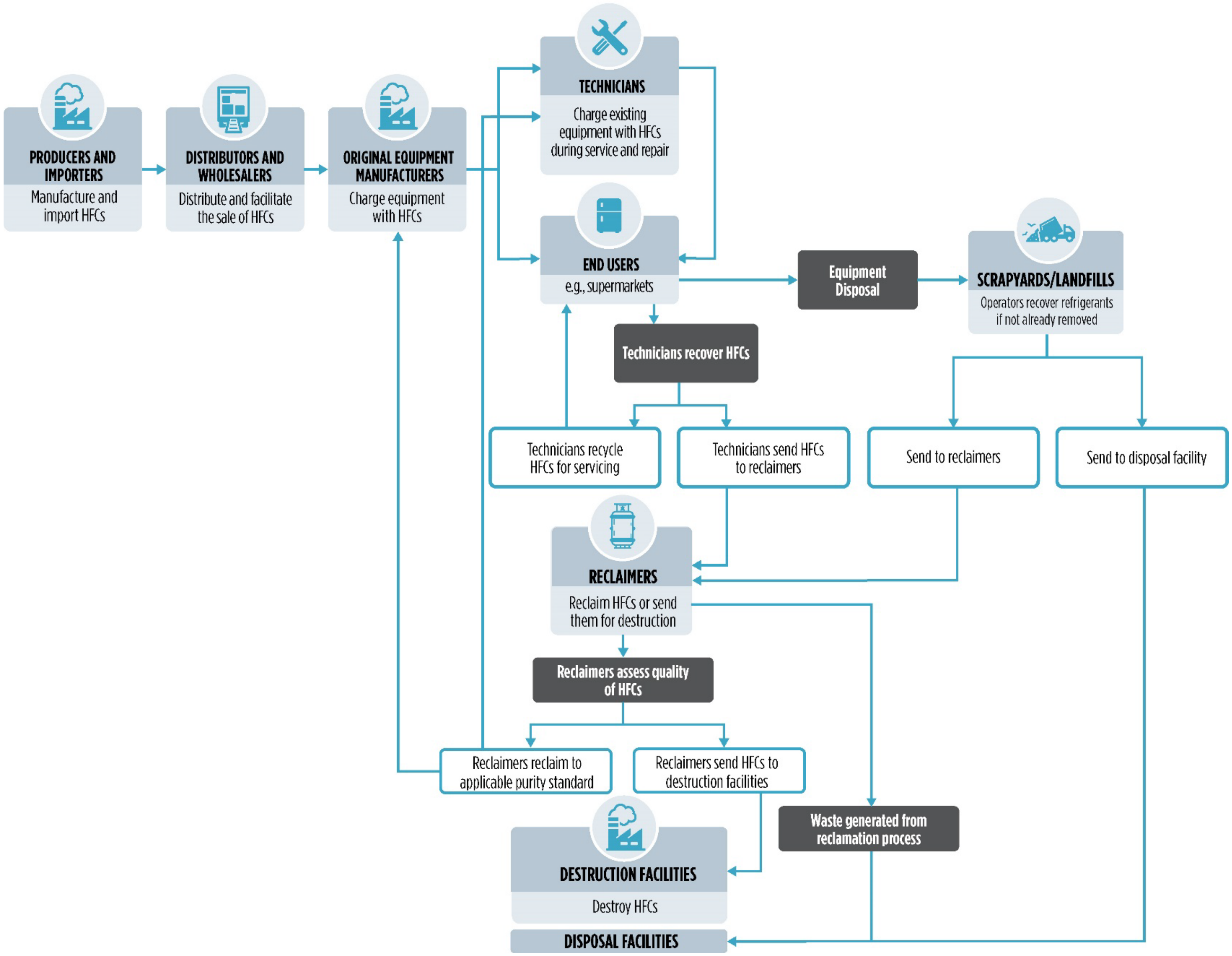
- Section 4 provides details on HFCs as refrigerants in the RACHP sector and particular subsectors within the RACHP sector.
- Section 5 describes the U.S. reclamation market and includes a description of reclamation methods and processes, cost drivers, and incentives.
- Section 6 describes safety considerations for technicians and consumers.
- Section 7 discusses the barriers and key challenges to increasing refrigerant reclamation.

Key Findings

Reclamation Process and Stakeholders

A diverse group of industry stakeholders engage in the sale and reclamation of HFCs. Figure ES-1 illustrates the general flow of HFCs through each of the key stakeholders, including producers and importers, wholesalers (including distributors), technicians, end users, reclaimers, destruction facilities, and scrap recyclers and landfills. In general, technicians recover HFCs and either recycle them for use in existing equipment, send them for reclamation, or send them for destruction. Depending on the quality of the recovered refrigerant, reclaimers decide whether to reclaim the HFCs to the required purity standard (*e.g.*, based on Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 700-2016) or send them to destruction facilities. Reclaimers may choose to send recovered refrigerants for destruction if they are too contaminated, making the reclamation process cost-prohibitive or infeasible from a technological standpoint. As stated, Figure ES-1 intends to depict a general movement of HFCs in the supply chain, and does not capture all possibilities or intricacies of certain transactions. Additional information on other pathways of the movement of HFC refrigerants and equipment is discussed in section 3 of this report.

Figure ES-1. General Flow Chart of HFCs Through Industry, Including Recovery and Reclamation



Reclamation Market

Since 2017, EPA has required that certified reclaimers report data on HFC reclamation activity in accordance with regulations promulgated under section 608 of the Clean Air Act (CAA). These requirements are analogous to the longstanding requirements for ozone-depleting refrigerants. As shown in Table ES-1,[3] the amount of reclaimed HFCs has remained relatively constant from 2017 to 2021 and showed a notable increase in 2022. From 2021 to 2022, the total amount of reclaimed HFCs increased by approximately 40 percent. The HFC refrigerants with the highest reclamation totals are R-134a (12.29 million pounds (lbs) total from 2017-2022) and R-410A (15.23 million lbs total from 2017-2022). R-134a and R-410A also the refrigerants that saw the largest increases in reclamation from 2021 to 2022, with increases of approximately 26 percent and 41 percent, respectively.

Table ES-1. HFC Refrigerant Reclamation Reported from 2017 to 2022 (lbs)

Refrigerant	2017	2018	2019	2020	2021	2022
R-134a	1,858,132	1,910,240	2,399,952	1,956,644	1,844,793	2,317,825
R-404A	486,719	506,639	485,338	478,556	416,352	443,342
R-407A	111,255	143,254	105,435	87,162	60,580	22,874
R-407C	167,445	167,248	213,668	315,424	366,521	474,205
R-410A	2,103,404	2,043,667	2,596,861	2,347,000	2,550,164	3,591,058
Other HFCs	363,311	479,261	258,486	206,029	173,022	757,282
Total	**5,090,266**	**5,250,309**	**6,059,740**	**5,390,816**	**5,411,433**	**7,606,586**

Table ES-2 presents data on reclaimed HFCs in terms of million metric tons of carbon dioxide equivalent ($MMTCO_2e$), a measure used to to compare the relative warming effects of greenhouse gases (GHGs) in the atmosphere based on their global warming potentials (GWPs) For context, the total consumption of HFCs in 2020 was 309 $MMTCO_2e$ (U.S. EPA, 2022a). It is expected that the HFC reclamation market will increase in future years as more refrigeration and air conditioning equipment using HFC refrigerants reach their end-of-life and virgin HFC supplies are restricted consistent with the AIM Act. One estimate predicts that under the HFC phasedown, reclaimed HFCs will increase in sales by $0.8 billion and add almost 4,000 jobs (Inforum et al., 2019).

Table ES-2. HFC Refrigerant Reclamation Reported Totals by Year ($MMTCO_2e$)

Refrigerant	2017	2018	2019	2020	2021	2022
R-134a	1.21	1.24	1.56	1.27	1.20	1.50
R-404A	0.87	0.90	0.86	0.85	0.74	0.78
R-407A	0.11	0.14	0.10	0.08	0.06	0.02
R-407C	0.13	0.13	0.17	0.25	0.29	0.38
R-410A	1.99	1.94	2.46	2.22	2.41	3.40
Other HFCs[a]	0.59	0.77	0.37	0.31	0.28	1.18
Total	**4.89**	**5.11**	**5.52**	**4.99**	**4.99**	**7.25**

[3] Refrigerant reclamation data as reported to EPA per requirements under section 608 of the CAA are current as of April 24, 2024.

Refrigerant	2017	2018	2019	2020	2021	2022

[a] Other HFCs were calculated in $MMTCO_2e$ using aggregated totals of each HFC reclaimed as reported during annual reporting per 40 CFR 82.164(d) and using their respective GWPs

Key Barriers to Increasing Reclamation

The report identifies some key barriers to increasing refrigerant recovery and reclamation:

- **Contamination, Blends, and Mixed Cylinders.** When cylinders contain refrigerant blends or different types of refrigerants, it is more difficult and time-consuming for reclaimers to process and reclaim the refrigerants.
- **Costs of Reclamation.** The cost of recovering and reclaiming refrigerant is increasing primarily due to new blends requiring new technologies. In addition, market fluctuations affect the relative price of reclaimed refrigerant to virgin refrigerant. Further, logistical costs, such as transporting recovered materials to the relatively few reclamation factilities nationwide and who bears that cost, also may factor in to the overall economics of reclaim.
- **Refrigerant Release Limits Recovery Potential.** When refrigerant is released from equipment, it results in less refrigerant available for recovery and reclamation. Accidental release and leakage rates vary depending on application and charge size, and may occur at different points throughout the lifetime of equipment, including during installation, servicing and maintenance, and at end-of-life. Intentional release, such as venting, may also occur.

1. Introduction

Subsection (h) of the American Innovation and Manufacturing (AIM) Act of 2020, titled "Management of Regulated Substances," directs the U.S. Environmental Protection Agency (EPA) to establish certain regulations for regulated substances[4] and their substitutes for the purposes of maximizing reclaiming and minimizing releases of regulated substances (used interchangeably with hydrofluorocarbons (HFCs) in this document) from equipment and ensuring the safety of technicians and consumers.

More specifically, subsection (h) directs EPA to promulgate regulations to control, where appropriate, any practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment that involves: a regulated substance, a substitute for a regulated substance, the reclaiming of a regulated substance used as a refrigerant, or the reclaiming of a substitute for a regulated substance used as a refrigerant.

Subsection (h) also provides for the Agency to consider options to increase opportunities for reclaiming HFCs used as refrigerants and potential approaches to coordinate regulations carrying out subsection (h) of the AIM Act with other EPA regulations that involve the same or a similar practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment, or reclaiming.

As part of implementing subsection (h), EPA is finalizing certain regulatory requirements[5] related to maximizing reclamation of regulated substances. This document, prepared for the purposes of subsection (h), provides background information on the refrigerant reclamation market in the United States and use of HFCs in the refrigeration, air conditioning, and heat pumps (RACHP) sector.

While this report focuses on the recovery and reclamation of regulated HFCs being used as refrigerants, subsection (h) of the AIM Act does not limit activities identified in subsection (h) only to refrigerants. [6] Although not a focus of this report, EPA understands that regulated HFCs and their substitutes recovered from other equipment, such as fire suppression systems, may be reprocessed and reused as well.[7]

This report provides background information on the reclamation for refrigerants in stationary equipment in the RACHP sector. This report is organized as follows:

- Section 1 provides an introduction and context of the AIM Act and reclamation.
- Section 2 provides background information on reclamation and EPA's regulatory authority over refrigerant reclamation as well as information on state actions pertaining to reclamation.

[4] The AIM Act lists 18 saturated HFCs, and by reference any of their isomers not so listed, that are covered by the statute's provisions, referred to as "regulated substances" under the Act (42 U.S.C. 7675(c)(1)).
[5] See final rule in Docket EPA-HQ-OAR-2022-0606 at www.regulations.gov.
[6] Subsection (h)(4), however, states that: "No regulation promulgated pursuant to this subsection shall apply to a regulated substance or a substitute for a regulated substance that is contained in a foam."
[7] See TSD titled "American Innovation and Manufacturing Act of 2020 – Subsection (h): Fire Suppression Sector" available in the docket in Docket EPA-HQ-OAR-2022-0606 at www.regulations.gov.

- Section 3 identifies key stakeholders in the reclamation industry and describes their roles and responsibilities.
- Section 4 provides the details on HFCs as refrigerants in the RACHP sector and particular subsectors within the RACHP sector.
- Section 5 describes the U.S. reclamation market and includes a description of reclamation methods and processes, cost drivers, and incentives.
- Section 6 describes safety considerations for technicians and consumers.
- Section 7 discusses the barriers and key challenges to increasing refrigerant reclamation.
- Section 8 includes references cited in the text.
- Appendix A includes the statutory text of subsection (h) of the AIM Act.

2. Background

Under the multilateral environment treaty known as *The Montreal Protocol on Substances that Deplete the Ozone Layer* (Montreal Protocol), all countries are phasing out the production and consumption of ozone-depleting substances (ODS).[8] Domestically, under title VI of the Clean Air Act (CAA), EPA is phasing out production and consumption of ODS consistent with the Montreal Protocol. In addition, title VI includes complementary measures, such as identifying safer substitutes and regulating use and disposal of ODS.

In the United States, ODS are regulated as class I or class II controlled substances. Class I substances, such as chlorofluorocarbons (CFCs) and halons, have higher ozone depletion potentials (ODPs), and their production and consumption were phased out in the United States with few exceptions. This means no one can produce or import virgin (newly produced) class I substances.

Class II substances are all hydrochlorofluorocarbons (HCFCs), which are transitional substitutes for many class I substances. Section 605 of the CAA establishes the U.S. phaseout targets for class II substances. EPA established the class II phaseout framework with a "worst-first" approach, which focused first on HCFC-141b, HCFC-142b, and HCFC-22 because they have the highest ODPs of all HCFCs. Since January 1, 2020, production and import of all HCFCs in the United States must be less than 0.5 percent of the HCFC baseline. Further, newly produced or imported HCFCs are limited to HCFC-123 and HCFC-124 and can only be used to service RACHP and fire suppression equipment that was manufactured before January 1, 2020.

The Montreal Protocol has successfully reduced the production and consumption of ODS; however, it resulted in a shift toward greater use of HFCs, which are potent GHGs that have GWPs that can be hundreds to thousands of times greater than carbon

[8] See *The Montreal Protocol on Substances That Deplete the Ozone Layer* at https://www.state.gov/key-topics-office-of-environmental-quality-and-transboundary-issues/the-montreal-protocol-on-substances-that-deplete-the-ozone-layer/#:~:text=The%20Montreal%20Protocol%2C%20finalized%20in,%2C%20fire%20extinguishers%2C%20and%20aerosols.

dioxide (CO_2). In 2016, in Kigali, Rwanda, countries agreed to an amendment to the Montreal Protocol, known as the Kigali Amendment, which provides for a global phasedown of the production and consumption of HFCs.

In 2020, Congress enacted the AIM Act, which directs EPA to phase down HFC production and consumption by 85 percent below historic baseline levels by 2036 and also includes other provisions for EPA to regulate HFCs. The AIM Act lists 18 saturated HFCs, and by reference any of their isomers not so listed, that are covered by the statute's provisions, referred to as “regulated substances” under the Act. Congress also assigned an “exchange value” to each regulated substance, which is numerically equivalent to the 100-year GWPs listed in the 2007 Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report.

The AIM Act authorizes EPA to address HFCs in three main ways: phasing down HFC production and consumption through an allowance allocation program; issuing certain regulations for purposes of maximizing reclamation and minimizing releases of HFCs and their substitutes from equipment; and facilitating sector-based transitions to next-generation technologies. The phasedown provisions are consistent with the Kigali Amendment to the Montreal Protocol. On October 31, 2022, the United States ratified the Kigali Amendment.[9]

This report focuses on the recovery and reclamation of regulated substances. Reclamation has played a key role in maintaining the supply of ODS during their phaseout, so that appliances and equipment can be used for their full useful lifetime and not retired prematurely. For example, reclaimed HCFC-22 may continue to be used for as long as it is available to service existing HCFC-22 systems (U.S. EPA, 2020). Reclamation is also expected to help ease the impacts of the phasedown of production and consumption of HFCs in accordance with the AIM Act.

2.1 What is Reclamation?

In this context, reclamation refers to the reprocessing of a recovered substance to an established specification for purity as verified using a prescribed analytical methodology. Reclamation can play an important role as the United States phases down HFC production and consumption. The reclamation process involves reprocessing and upgrading recovered substances through such mechanisms as filtering, drying, distillation, and chemical treatment to restore the substance to industry specifications (Stratus Consulting 2010). The AIM Act defines both reclaim and reclamation as follows (42 U.S.C. 7675(b)(9)):

> *(A) the reprocessing of a recovered regulated substance to at least the purity described in standard 700–2016 of the Air-Conditioning, Heating,*

[9] More information is available at: https://www.state.gov/u-s-ratification-of-the-kigali-amendment/

and Refrigeration Institute (or an appropriate successor standard adopted by the Administrator); and

(B) the verification of the purity of that regulated substance using, at a minimum, the analytical methodology described in the standard referred to in subparagraph (A).

The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 700-2016 (AHRI Standard 700) establishes purity specifications and methods of testing to verify the composition of refrigerants regardless of source (new, reclaimed, and/or repackaged) for use in new and existing refrigeration and air conditioning products (AHRI, 2019a).

By bolstering the current supply of HFCs with refrigerants from existing systems, reclamation supports a smooth transition to alternatives. In addition, reclamation can minimize disruption of the current capital stock of equipment by allowing its continued use with existing refrigerant supplies (U.S. EPA, 2016a).

Reclamation can also help avoid supply shortages of virgin refrigerants and can insulate the industry against price spikes that could affect the servicing of existing systems using HFCs. Refrigerant reclamation creates value for used refrigerants recovered from equipment, for example, during routine servicing, and helps embed good practices in refrigerant management throughout the supply chain.

A key example of the benefits of reclamation or recycling is the use of reclaimed or recycled ODS whose production has been phased out. This sector has a long history of using recycled ODS for both servicing and new equipment. For example, HCFC-123 can be recovered from chillers and reprocessed for reuse in fire suppression application where there is continued need.

Recycled halons are also important for use in fire suppression systems. EPA phased out the production and importation of virgin halons in the United States in 1994. Since that time, there has been continued demand for halons in both newly manufactured fire suppression equipment and servicing of existing equipment. Recycled halons have been the only supply in the United States for specialty fire suppression applications. Sources of recycled halons include stockpiles and recovered halons from cylinders both in the United States and abroad.[10]

The management of halons in the United States over the last several decades demonstrates a model of collaboration between industry, government, and key users, effective regulations to reduce emissions, a smooth transition to safer alternatives through revisions to industry standards, voluntary industry codes of practice, maintenance of halon banking, and government halon reserves. Existing halon stocks are purchased by commercial recyclers from decommissioned equipment, reprocessed to industry specifications, and sold back into the market. Similar to the handling of

[10] For additional information on the halons program, please visit https://www.epa.gov/ozone-layer-protection/halons-program.

refrigerants under section 608 of the CAA, EPA's regulations addressing halons, at 40 Code of Federal Regulations (CFR) part 82, subpart H, include certain prohibitions on intentional release (venting) of halons and requirements for technicians to be trained regarding halon emission reduction.

Ultimately, demand for halons have been satisfied with recycled halons, ensuring equipment can be serviced and investments are not stranded. Recycled halons have been used for over 25 years to charge new fire suppression equipment and more recently recycled HCFCs have similarly been used in a fire suppression blend (U.S. EPA, 2020). Similar to the importance of recycled halons for use in new and existing equipment, reclaimed HFCs are and will continue to be important to help to meet demands for uses of HFCs in RACHP equipment.

2.2 Federal Statutory and Regulatory Provisions

Two sections in title VI of the CAA that are particularly relevant to reclamation are sections 608 and 609. EPA's current regulations under these sections of the CAA require certain refrigerant management practices by reclaimers, those who buy or sell refrigerant, technicians, owners and operators of air conditioning and refrigeration systems, and others. The refrigerant management regulations are at 40 CFR part 82, subpart F (subpart F). These requirements generally apply to the management of ODS and substitutes for ODS, such as HFCs, used as refrigerants.[11] As ODS production and import have been phased out under title VI of the CAA, refrigerant reclamation has provided an important source of ODS refrigerants to service existing equipment. Refrigerant recovery, recycling, and reclamation occur primarily in stationary and mobile air conditioning and refrigeration applications.

CAA Section 608: National Recycling and Emission Reduction Program

Section 608 of the CAA, titled "National Recycling and Emission Reduction Program," has three main components. First, section 608(a) requires EPA to establish standards and requirements regarding the use and disposal of class I and class II substances. The second component, section 608(b), requires that the regulations issued pursuant to subsection (a) contain requirements for the safe disposal of class I and class II substances. The third component, section 608(c), prohibits the knowing venting, release, or disposal of ODS refrigerants and their substitutes in the course of maintaining, servicing, repairing, or disposing of appliances or industrial process refrigeration (IPR).

Section 608 regulations under Title 40 CFR part 82, subpart F define reclaim to mean to "reprocess recovered refrigerant to all of the specifications in appendix A of this subpart (based on AHRI Standard 700-2016, *Specifications for Refrigerants*) that are applicable to that refrigerant and to verify that the refrigerant meets these specifications using the

[11] One exception to this general rule is 40 CFR 82.157, which relates to appliance maintenance and leak repair, and which only applies to appliances containing an ODS as of April 10, 2020.

analytical methodology prescribed in section 5 of appendix A of this subpart" (40 CFR 82.152 (definition of "reclaim")).

Under subpart F, recovery involves removing refrigerant in any condition from an appliance and storing it in an external container without necessarily testing or processing it in any way (40 CFR 82.152 (definition of "recover")).

Similarly, under subpart F, recycling a refrigerant involves extracting it from an appliance and cleaning the refrigerant for reuse in equipment of the same owner without meeting all of the requirements for reclamation. In general, recycled refrigerant is refrigerant that is cleaned using oil separation and single or multiple passes through devices, such as replaceable core filter-driers, which reduce moisture, acidity, and particulate matter (40 CFR 82.152 (definition of "recycle")).

Furthermore, EPA regulations under section 608 of the CAA address the handling and recycling of refrigerants used in stationary refrigeration and air conditioning systems. Several of these requirements are particularly relevant to reclamation, including:

- Venting Prohibition: consistent with the venting prohibition under section 608(c) of the CAA, EPA's subpart F regulations at 40 CFR 82.154(a) prohibit individuals from knowingly venting or otherwise releasing into the environment ODS refrigerants and their substitutes (such as HFCs), while maintaining, servicing, repairing, or disposing of air conditioning or refrigeration equipment, while also providing for certain limited exceptions from this prohibition.
- Recovery: With certain limited exceptions, under 40 CFR 82.156, before opening (*e.g.*, for servicing) or disposing of an appliance, technicians must ensure refrigerant is evacuated from air conditioning or refrigeration equipment to established vacuum levels. Similar requirements apply to persons opening or disposing of a small appliance, motor vehicle air conditioner (MVAC), or MVAC-like appliances.[12]
- Reclamation: Under 40 CFR 82.154(d)(1), the sale of used refrigerant is prohibited, with certain limited exceptions. Under one of those exceptions, used

[12] EPA's subpart F regulations at 40 CFR 82.152 define "MVAC-like appliance" to mean "a mechanical vapor compression, open-drive compressor appliance with a full charge of 20 lbs or less of refrigerant used to cool the driver's or passenger's compartment of off-road vehicles or equipment. This includes, but is not limited to, the air-conditioning equipment found on agricultural or construction vehicles. This definition is not intended to cover appliances using R-22 refrigerant." By contrast, EPA's subpart F regulations at 40 CFR 82.152 define "Motor vehicle air conditioner (MVAC)" as "any appliance that is a motor vehicle air conditioner as defined in 40 CFR part 82, subpart B." The subpart B regulations at 40 CFR 82.32 provide that: "Motor vehicle air conditioners means mechanical vapor compression refrigeration equipment used to cool the driver's or passenger's compartment of any motor vehicle. This definition is not intended to encompass the hermetically sealed refrigeration systems used on motor vehicles for refrigerated cargo and the air conditioning systems on passenger buses using HCFC-22 refrigerant." Further, the subpart B regulations at 40 CFR 82.32 provide that: "Motor vehicle as used in this subpart means any vehicle which is self-propelled and designed for transporting persons or property on a street or highway, including but not limited to passenger cars, light duty vehicles, and heavy-duty vehicles. This definition does not include a vehicle where final assembly of the vehicle has not been completed by the original equipment manufacturer."

refrigerant may be resold if it has been reclaimed by an EPA-certified reclaimer. Under 40 CFR 82.164, reclaimers must also follow certain practices[13] when reclaiming such refrigerants for sale to a new owner, such as:

- Not releasing more than 1.5 percent of the refrigerant during the reclamation process;
- Reclaiming refrigerant such that it meets all the required specifications (based on AHRI Standard 700-2016, Specifications for Refrigerants) that are applicable to that refrigerant; and
- Verifying that each batch of refrigerant reclaimed meets these specifications using the required analytical methodology.

CAA Section 609: Servicing of Motor Vehicle Air Conditioners

Section 609 of the CAA specifically addresses the servicing of MVACs and require EPA to promulgate regulations establishing standards and requirements regarding the servicing of MVACs. EPA's regulations under section 609 are at 40 CFR part 82, subpart B. Under those regulations, any person repairing or servicing an MVAC system for consideration (*i.e.*, payment in any form) involving the use of refrigerant[14] must use approved refrigerant recycling equipment and be properly trained and certified. These regulations also require recovered refrigerant to be either recycled or reclaimed, consistent with certain regulatory requirements, before it can be charged or recharged into an MVAC system. This requirement applies even if the refrigerant is being returned to the system from which it was removed.

AIM Act: Recovery and Reclamation

Under the AIM Act, the terms reclaim and reclamation are both defined to mean "(A) the reprocessing of a recovered regulated substance to at least the purity described in standard 700-2016 of the Air-Conditioning, Heating, and Refrigeration Institute (or an appropriate successor standard adopted by the Administrator); and (B) the verification of the purity of that regulated substance using, at a minimum, the analytical methodology described in the standard referred to in subparagraph (A)" (42 U.S.C. 7675(b)(9)). The term **recover** is defined in the AIM Act to mean "the process by which a regulated substance is (A) removed, in any condition, from equipment; and (B) stored in an external container, with or without testing or processing the regulated substance" (42 U.S.C. 7675(b)(10)). These are similar but not identical to EPA's existing definitions in the refrigerant management regulations.

Subsection (h) of the AIM Act includes provisions related to the management of regulated HFCs and their substitutes. Subsection (h)(1) provides that "[f]or purposes of

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[13] A complete list of requirements is available at 40 CFR 82.164, and they are briefly described in an EPA fact sheet for reclaimers, available at https://www.epa.gov/sites/default/files/2016-09/documents/608_fact_sheet_reclaimers_0.pdf.

[14] The term "refrigerant" as used in CAA Section 609 has included class I or class II substances and substitutes since November 15, 1995.

maximizing reclaiming and minimizing the release of a regulated substance from equipment and ensuring the safety of technicians and consumers," EPA "shall promulgate regulations to control, where appropriate, any practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment … that involves (A) a regulated substance; (B) a substitute for a regulated substance; (C) the reclaiming of a regulated substance used as a refrigerant; or (D) the reclaiming of a substitute for a regulated substance used as a refrigerant." Subsection (h) also provides that "[i]n carrying out this section, the Administrator shall consider the use of authority available to the Administrator under this section to increase opportunities for the reclaiming of regulated substances used as refrigerants" (subsection (h)(2)(A)) and authorizes EPA in promulgating regulations carrying out subsection (h) of the AIM Act to "coordinate those regulations with any other [EPA] regulations" involving "the same or a similar practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment," or reclaiming (subsection (h)(3)). Such regulations could potentially include the refrigerant management program established under title VI of the CAA.

2.3 State Statutory and Regulatory Provisions

California

In December 2021, the California Air Resources Board (CARB) finalized amendments to its regulation on prohibitions on the use of certain HFCs in stationary refrigeration, stationary air conditioning, and other end uses. Section 95376 of this regulation established the Refrigerant Recovery, Reclaim, and Reuse Requirements (R4 Program), which requires that manufacturers of two types of air conditioning end-uses, *other air conditioning (new) equipment, residential and non-residential*;[15] and *variable refrigerant flow (VRF) equipment*, must use a minimum amount of reclaimed refrigerant[16], starting in 2023.

For other new air conditioning equipment, residential and non-residential, the regulations require that manufacturers utilize a volume of reclaimed refrigerant in 2023 and 2024 that is approximately 10 percent of the total HFCs entered into California in the equipment in the baseline years. For VRF equipment, the regulations require that manufacturers utilize a volume of reclaimed refrigerant in 2023 and 2024 that is approximately 15 percent of the total HFCs entered into California in this equipment in the baseline years, and then increases to a 25 percent reclaim requirement in 2025. The reclaimed refrigerant requirement can be met using the reclaimed refrigerant for factory charge of new equipment, field charge of new equipment, or servicing of existing

[15] "Other Air-conditioning" or "Other Air-conditioning Equipment" is defined in California's regulation as any residential or non-residential air-conditioning equipment or air-conditioning system not otherwise defined as "room air conditioner," "wall air conditioner," "window air conditioner," "packaged terminal air conditioner (PTAC)," "packaged terminal heat pump (PTHP)," "portable air conditioner," "residential dehumidifier," or "variable refrigerant flow (VRF) system." (17 CCR section 95373 2021).

[16] The minimum amount is calculated according to a baseline which uses the average number of pounds of refrigerant in equipment that entered California in 2018 and 2019. For manufacturers with no shipments into California in those years, the requirement for using certified reclaimed refrigerant will be based on the current year the refrigerant enters California.

equipment. The requirement may also be met by using a refrigerant with a GWP of less than 750 during these activities. The reclaimed refrigerant does not need to be sourced from inside the state and can be reclaimed from recovered refrigerant from any geographic location. Furthermore, CARB defines "certified reclaimed refrigerant" for the purposes of this requirement as not containing more than 15 percent virgin refrigerant by weight (17 CCR § 95371-95379 2021).

Although similar reclamation programs have been discussed in proposed rulemakings for other states, California is the first state to implement such a reclaim program in the United States. As the requirements under the R4 Program did not begin until 2023, information is not available about the effect this program may have on reclamation rates. Additionally, CARB recently approved an update to the Small Containers of Automotive Refrigerant regulation, which will require refrigerant sold in these containers in California to be 100 percent reclaimed by 2027 (CARB, 2023).

Washington

In 2021, the State of Washington finalized House Bill 1050, which expanded HFC restrictions. The new law set a maximum GWP for HFCs used in new stationary air conditioning equipment, new and existing stationary refrigeration equipment, and ice rinks. House Bill 1050 also directed the Washington State Department of Ecology (DOE) to establish and implement a refrigerant management program to address refrigerant emissions from air conditioning and refrigeration equipment with charge sizes of 50 lbs or more (Washington DOE, 2022). Lastly, House Bill 1050 mandated the Washington DOE to prepare a report summarizing approaches for state regulators to manage the end-of-life and disposal of refrigerants. Washington's report found an "incentive-based approach incorporating extended producer responsibility may maximize the recovery and disposal of refrigerants" and that a "fee-based program that provides incentives to consumers and businesses for proper refrigerant disposal, recovery, reclaim, and reuse would significantly reduce HFC emissions" (Drumheller et al., 2021).

Washington adopted its HFC rule in November 2023 and became effective on December 31, 2023, further implementing House Bill 1050. Washington's refrigerant management program (RMP) requires specific leak detection and monitoring requirements for systems with a full charge of 50 lbs or more of a refrigerant with a GWP of 150 or more. Leak repair and recordkeeping requirements began on January 1, 2024, for all sizes of refrigeration and air conditioning systems that are subject to the RMP. Systems with a full charge greater than or equal to 1,500 lbs must install an automatic leak detection system for their system(s) by January 1, 2025. Systems with charge sizes of 50–1,499 lbs must have either annual or quarterly leak inspection requirements depending on the charge size of the system. Leak inspections would also be required any time an amount of refrigerant equal or greater to 1 percent of full charge is added to a system. Washington's proposed RMP has strict leak rate thresholds which system owner/operators must adhere to. Leak rates must be reported to Washington DOE each time a leak inspection is completed. A 12-month rolling average leak rate is calculated for each system. If a threshold is breached, the owner/operator must repair the system. If the system cannot be repaired within the time allotted in Washington's rule proposal, the owner/operator must work with Washington DOE to create and implement a retrofit or retirement plan for the system. The rule also establishes certain registration, recordkeeping, and reporting requirements for wholesalers, distributors, and reclaimers. Specifically, these entities would have requirements related to the amount of GWP greater than 150 HFCs they wholesale, distribute, or reclaim (Washington DOE, 2023a & 2023b).

On February 9, 2024, the Washington State Legislature introduced House Bill 2401 which would require producers of HFCs to register with the state and participate in a refrigerant stewardship organization. Other entities in the supply chain, including reclaimers, must register report information to the organization (Washington State Legislature, 2024a & 2024b).

New York

In September 2020, the New York Department of Environmental Conservation (NYDEC) finalized *Part 494 Hydrofluorocarbon Standards and Reporting* establishing prohibitions for certain HFCs in air conditioning and refrigeration equipment, aerosol propellants, and foam end-uses. These prohibitions went into effect starting in 2021 (NYDEC 2024). In December 2023, NYDEC proposed amendments to its Part 494 HFC regulations proposing additional prohibitions for certain HFCs in specific end uses, limiting the amount of virgin HFCs allowable in reclaimed refrigerants to 15% by weight, requiring specific labeling and disclosure requirements for reclaimed refrigerants, requiring registration and reporting for reclaimers operating in the state of New York, and establishing a refrigerant management program for stationary refrigeration and air conditioning equipment with a refrigerant charge size greater than 50 pounds. One notable difference between NYDEC's proposal and other state and Federal HFC regulations is the use of 20-year GWP values instead of 100-year GWP values; the department defines regulated substances under the proposal as any chemical intended for use in specific sectors that has a 20-year GWP value greater than 10. Starting January 1, 2025, the proposal's labeling and disclosure provision requires manufacturers of specific equipment to state, in part, if the regulated substances used in equipment are of reclaim in origin. Under the proposal, reclaimers are required to register with the department by January 1, 2025, and are subject to annual reporting beginning calendar year 2026 (NYDEC, 2023).

NYDEC's proposed refrigerant management program for refrigeration and air conditioning equipment with a full charge of 50 pounds or more begins January 1, 2025. The proposal requires owners or operators to meet specific labeling and equipment registration requirements depending on charge size starting as early as June 1, 2025. The RMP would require the installation of an ALD system for large refrigeration equipment with a charge size capacity of 1,500 pounds or more and establish monthly, quarterly, or annual leak inspections for equipment depending on charge size. The proposed RMP also establishes leak repair requirements for owners or operators to fix any detected leak within 14-days. Finally, the proposal's RMP would require owners or operators of specific equipment to submit annual reports to the Department (NYDEC, 2023).

Other States

While California, Washington, and New York have enacted comprehensive refrigerant management regulations in addition to prohibitions for the use of certain HFCs in specific end-uses nine additional states have adopted similar prohibitions for HFCs. Colorado, Delaware, Massachusetts, Maryland, Maine, New Jersey, New York, Rhode Island, Virginia, and Vermont have enacted legislation and/or adopted regulations that prohibit the use of certain HFCs in specific end-uses such aerosols, refrigerated appliances, and foams. Additionally, since late 2022, the New York State Department of Environmental Conservation (NYSDEC) has conducted outreach to local governments and stakeholders to solicit feedback on their intended updates to their HFC regulations.

2.4 EPA Outreach

EPA has performed various outreach activities in preparing this updated report on the status of reclamation in the United States. In October 2021, EPA released a draft version of this report accompanying a Notice of Data Availability (NODA) (87 FR 62843, October 17, 2022). EPA solicited stakeholder feedback and held a public stakeholder meeting shortly after the NODA was published on November 9, 2022. EPA received eleven comments in response to the NODA from stakeholders, including reclaimers, environmental non-governmental organizations (eNGOs), original equipment manufacturers (OEMs), industry organizations, and a private citizen.[17] Commenters provided input on a variety of topics. They noted the importance of tackling certain barriers to increased reclamation and availability of reclaimed HFCs on the market. Such barriers included increasing recovery of refrigerants, handling mixed refrigerants returned to reclaimers, and reclaiming certain patented blends. Commenters also provided input on consideration for a clear standard of what constitutes reclaimed HFCs, as well as improved tracking of HFCs in the supply chain. Further, some commenters noted opportunities for requiring the use of reclaimed materials in certain uses (*e.g.*, first charge of certain equipment).

EPA also held additional public stakeholder meetings to solicit feedback. On March 16, 2023, EPA held a public stakeholder meeting with a focus on reclamation. The webinar was attended by reclaimers, state and local governments, eNGOs, industry organizations, and OEMs. Stakeholders provided feedback on similar topics, including the barrier of increasing recovery to then increase reclamation of HFCs. EPA also held a public webinar via EPA's GreenChill Partnership Program on April 12, 2023, and heard similar feedback. On October 19, 2023, EPA published the proposed rule, "Phasedown of Hydrofluorocarbons: Management of Certain Regulated Substances under Subsection (h) of the American Innovation and Manufacturing Act of 2020", also

[17] See docket ID EPA-HQ-OAR-2022-0606.

called the Emissions Reduction and Reclamation (ER&R) rule, and accepted public comments through December 18, 2023 (U.S. EPA 2023a).

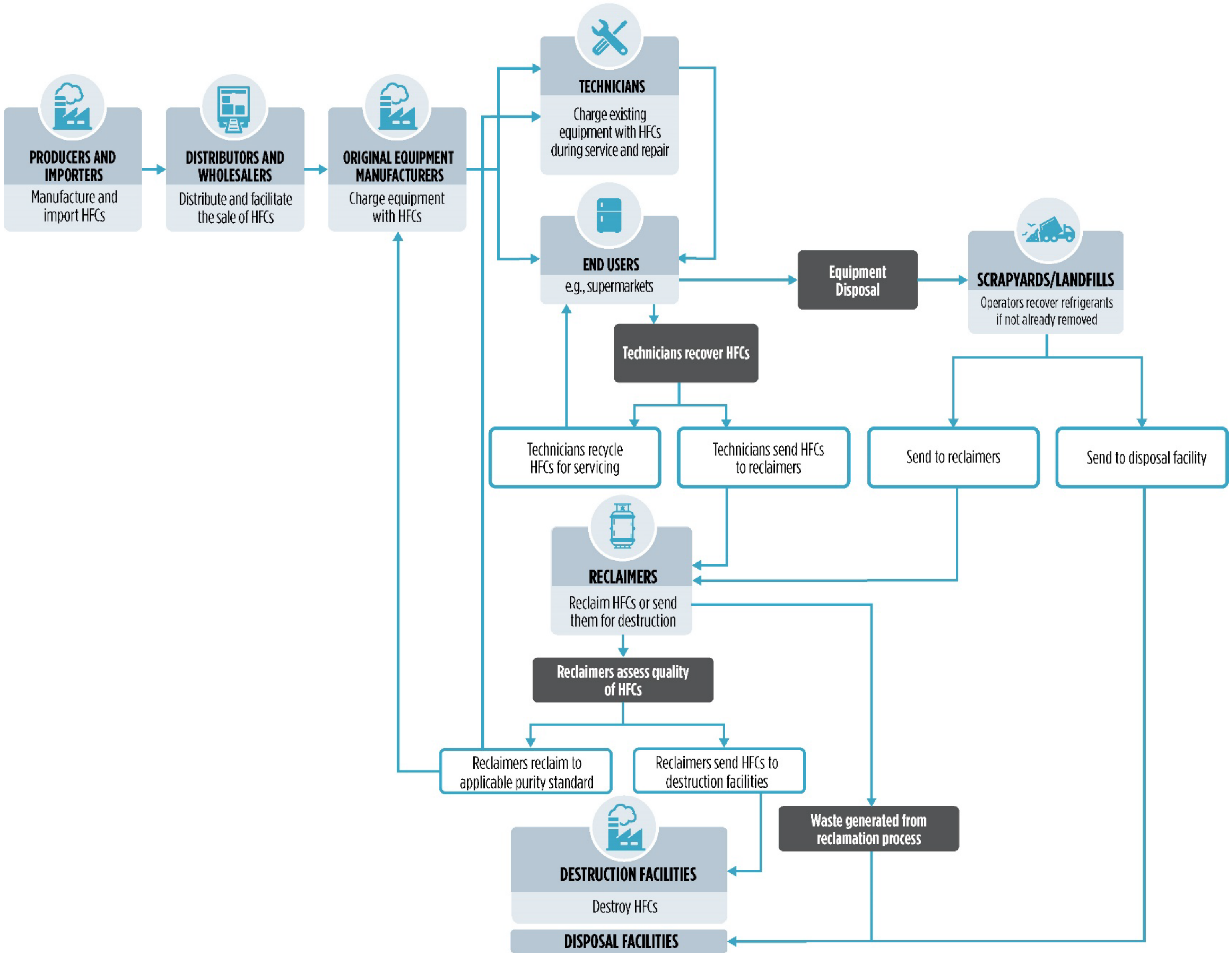
3. Reclamation Stakeholders

3.1 Overview

A diverse mix of industry stakeholders engage in the sale and reclamation of HFCs. Figure 1 illustrates the general flow of HFCs through each of the key stakeholders, including producers and importers, wholesalers (including distributors), end users, reclaimers, destruction facilities, and scrap recyclers and landfills. In general, technicians may recover HFCs and either recycle them for use in existing equipment, send them for reclamation, or send them for destruction. Depending on factors including the quality of the recovered refrigerant, reclaimers decide whether to process the HFCs to the applicable purity standard (*e.g.*, based on AHRI Standard 700-2016) or send them for destruction. For example, the market price of the refrigerant, among other factors, may influence whether a reclaimer will choose to reclaim lower quality recovered refrigerant or send it offsite for destruction. Reclaimers may choose to send recovered refrigerants for destruction if they are too contaminated and reclamation is deemed not technologically and/or economically feasible.

As EPA understands, and based on comments received in response to the NODA published in October 2022, there are other pathways for the movement of HFCs (virgin, reclaimed, or recovered) and equipment that use refrigerants that contain HFCs. As noted in the previous paragraph, Figure 1 is provided as an example of the general movement of HFCs and equipment in the supply chain. In some cases, OEMs may have agreements with producers to purchase directly from them to use in equipment that is charged by an OEM before being sold. Further, OEMs typically distribute their equipment to a wholesaler or distributor rather than sell directly to an end user. Service technicians who recover refrigerant may return the refrigerant to wholesalers or distributors who collect the recovered refrigerant and then send to a reclaimer when a sufficient amount is collected. After reclaimers have reclaimed refrigerants to the applicable purity standard, they may either distribute the reclaimed refrigerant through wholesalers or distributors or sell directly to OEMs. Typically, contractors or technicians would obtain refrigerants (virgin or reclaimed) by way of a wholesaler or distributor that are needed to perform servicing, repair, or installation jobs.

Figure 1. General Flow Chart of HFCs through Industry, including Recovery and Reclamation



3.2 Reclaimers

EPA certifies refrigerant reclaimers and publishes a list of their names and contact information. As of April 2024, there are over 60 EPA-certified refrigerant reclaimers.[18] Reclaimers receive refrigerant recovered from existing RACHP equipment and process the refrigerant through various means to achieve a targeted purity and blend composition. Reclaimers typically inspect the recovered refrigerant that they receive to determine whether the refrigerant is technologically and/or economically feasible to reclaim or should be destroyed. At least one reclaimer has capacity to destroy refrigerant themselves, while some may pay destruction companies or facilities with the capability to destroy the refrigerant (U.S. EPA, 2018). Reclaimers may pay wholesalers and technicians for the recovered refrigerant or may charge a fee for the recovered refrigerant, especially if the recovered refrigerants must be destroyed.

For quantities that can be reclaimed, reclaimers sell the refrigerant back into the supply chain through equipment or refrigerant-specific wholesalers or directly to RACHP technicians or RACHP original equipment manufacturers (OEMs). EPA is aware of at least one reclaimer that offers a line of products that are marketed as reclaimed.[19] In interviews with reclaimers in 2018 and 2019,[20] EPA learned about the various ways in which reclaimers sell refrigerant back into the supply chain. From those interviews, EPA understands that reclaimers may sell exclusively to wholesalers, directly to technicians and contractors, directly to OEMs, or through a third-party agent.

3.3 Wholesalers and Distributors

Wholesalers include distribution companies that provide a full range of RACHP equipment, components, and refrigerants, as well as those that focus exclusively on refrigerants. The wholesalers sell virgin or reclaimed refrigerant to RACHP technicians, who then use the refrigerant to charge customer equipment. Currently, refrigerant is not typically marketed or sold by wholesalers or distributors as “reclaimed refrigerant.”

Wholesalers may sell or otherwise provide empty recovery cylinders to technicians so they can recover refrigerant from existing RACHP equipment and return the full cylinders with recovered refrigerant to the wholesalers. Wholesalers then provide the recovered refrigerant to reclaimers for processing and may facilitate any credits or fees for the refrigerant recovered by technicians.

3.4 Technicians

EPA certifies technicians per the regulations under sections 608 and 609 of the CAA (40 CFR 82.161, 40 CFR 82.40). Technicians include contractors that install and service RACHP systems for residential, commercial, and industrial customers, independent

[18] For a list of EPA-certified reclaimers, please see https://www.epa.gov/section608/epa-certified-refrigerant-reclaimers.

[19] Hudson Technologies, Emerald Refrigerants. More information available at: https://www.hudsontech.com/refrigerants/emerald-refrigerants/

[20] Between 2018 and 2019, EPA conducted interviews with eight reclaimers to obtain more information on the industry, including reclamation technologies and equipment and potential challenges and barriers.

operators, and in-house technicians employed by larger commercial and industrial facilities (*e.g.*, food retailers), as well as those repairing or servicing MVACs for consideration (*i.e.*, payment of any form). Technicians may purchase virgin or reclaimed refrigerant from wholesalers, and sometimes directly from reclaimers. Similarly, some technicians may return recovered refrigerant to wholesalers or reclaimers in smaller quantities on a daily or weekly basis, whereas others may store refrigerant for less-frequent returns. Many technicians will handle refrigerant recovery and processing themselves, although some use subcontractors who specialize in equipment disposal and refrigerant recovery so they can focus on installations and servicing.

3.5 Landfill Operators, Scrap Metal Recyclers, and Disposal Facilities

Final processors, including but not limited to landfill operators, scrap metal recyclers, and disposal facilities, are responsible for ensuring that refrigerant is recovered from equipment before the equipment's final disposal. Equipment that typically enters the waste stream with its refrigerant charge intact (e.g., MVACs, household refrigerators and freezers, and window unit air conditioners) must be disposed of in accordance with the disposal requirements under 40 CFR 82.155(b). These requirements include recovering refrigerant from equipment, verifying using a signed statement that refrigerant that had not leaked previously has been recovered (or that the refrigerant has leaked out of the appliance), and keeping on-site records of all signed statements or contracts for three years.

3.6 Destruction Facilities

Reclaimers may send contaminated or less valuable HFCs or ODS that they choose not to reclaim to a destruction facility, an entity which is responsible for the destruction of ODS and HFCs. Destruction involves the near complete extermination of a chemical using biological, chemical, thermal, or other means, as described under the alternative treatment standards of Table 1 to 40 CFR 268.45. As of April 2024, 40 CFR 84.29 has designated twelve approved technologies for the destruction of HFCs (excluding HFC-23) and eight technologies approved for the destruction of HFC-23. The destruction of HFCs prevents the emissions of these high GWP substances into the atmosphere, at the cost of these chemicals no longer being available for reclamation and reuse.

4. Current Subsectors and Applications using Refrigerants

In general, refrigerants are selected based on their use in equipment in specific subsectors and applications within the RACHP sector. For the purposes of this report, EPA assessed the refrigerants used in the RACHP subsectors. While there are many ways to categorize subsectors and applications, we are using the general categories as established in EPA's Vintaging Model (VM)[21] (U.S. EPA, 2023b). As such, the categories that the VM uses may include a group of subsectors. For example, the commercial refrigeration category in the VM would include various subsectors, such as

[21] EPA's Vintaging Model of ODS Substitutes - *https://www.epa.gov/ozone-layer-protection/epas-vintaging-model-ods-substitutes*.

supermarket systems, self-contained equipment for food retail, and more. Refrigerants that are currently in use may be available for recovery and possible reclamation when the equipment using the refrigerant reach their end-of-life or cease operation.

EPA's VM estimates the annual emissions from sectors that have used ODS and alternatives, in particular HFCs. The VM estimates the use and emissions of each of the substances separately for each of the ages or "vintages" of equipment. The VM is used to produce the estimates of GHG emissions in the official U.S. GHG Inventory and is updated and enhanced annually. Information on the version of the model used to support the finalized ER&R rulemaking under subsection (h) of the AIM Act, the various assumptions used, and HFC emissions may be found in EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2014* (U.S. EPA, 2016c).

The peer-reviewed VM utilizes detailed information on more than 60 end uses across the five major industrial sectors that previously relied on ODS and have more recently used HFCs (*i.e.*, refrigeration and air conditioning, foams, aerosols, solvents, and fire suppression) (U.S. EPA, 2018b). Each end use is modeled differently based on its characteristics such as pieces of equipment in operation, the number added or removed annually, the average amount of HFC used and emitted over time from each item, typical lifetime of operation, and growth/decline rate in the U.S. market. As each end use transitions from an ODS to one or more HFC(s) and possibly other options, the model tracks annual vintages and calculates the amount of each chemical in use, emitted, and the consumption needed to both support new products and service existing products (*e.g.*, to "top-off" leaks from air conditioners). The VM estimates the use and emissions of ODS substitutes—including HFCs and other substitutes—by taking the following steps:

1. Gather historical emission data. The VM is populated with information on each end use, taken from published and confidential sources and industry experts.

2. Simulate the implementation of new, non-ODS and HFC replacement technologies. The VM uses detailed characterizations of the historical and current uses of HFCs to simulate the implementation of new technologies. This step can be expanded to include secondary transitions from HFCs to other technologies as a means to estimate the HFC reductions achievable with such actions.

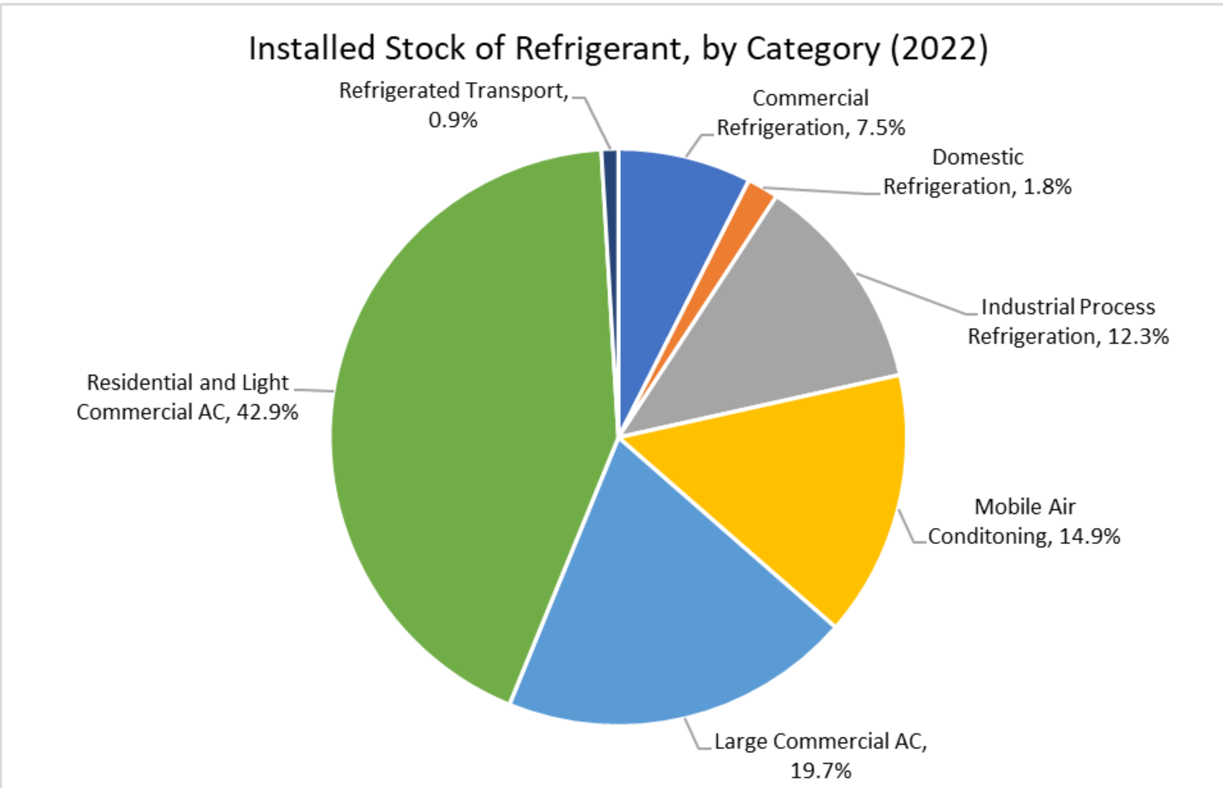
3. Estimate emissions of the ODS substitutes and HFC substitutes. The chemical use is estimated from the amount of substitutes that are required each year for the manufacture, installation, use, or servicing of products. The emissions are estimated from the emission profile for each vintage of equipment or product in each end use. By aggregating the emissions from each vintage, a time profile of emissions from each end use is developed.

To project into the future, each end use is assigned a growth rate based on the overall growth seen from the past several years. In some cases, other data are used to estimate growth rates: for instance, the U.S. Energy Information Administration's Annual

Energy Outlook projections for automobile sales and new single-family housing starts are used to estimate future growth in the MVAC and residential split system air conditioning end-uses, respectively (EIA, 2009).

Figure 2 shows the estimated stock of refrigerants in 2022 in various RACHP subsectors.[22] The total installed stock of refrigerants is 1.1 million metric tons. Specifically, the air conditioning subsectors account for approximately 77.5 percent of the installed stock, with the greatest amount in residential and light commercial air conditioning (42.9 percent). The refrigeration subsectors account for approximately 22.5 percent of the installed stock of refrigerants.

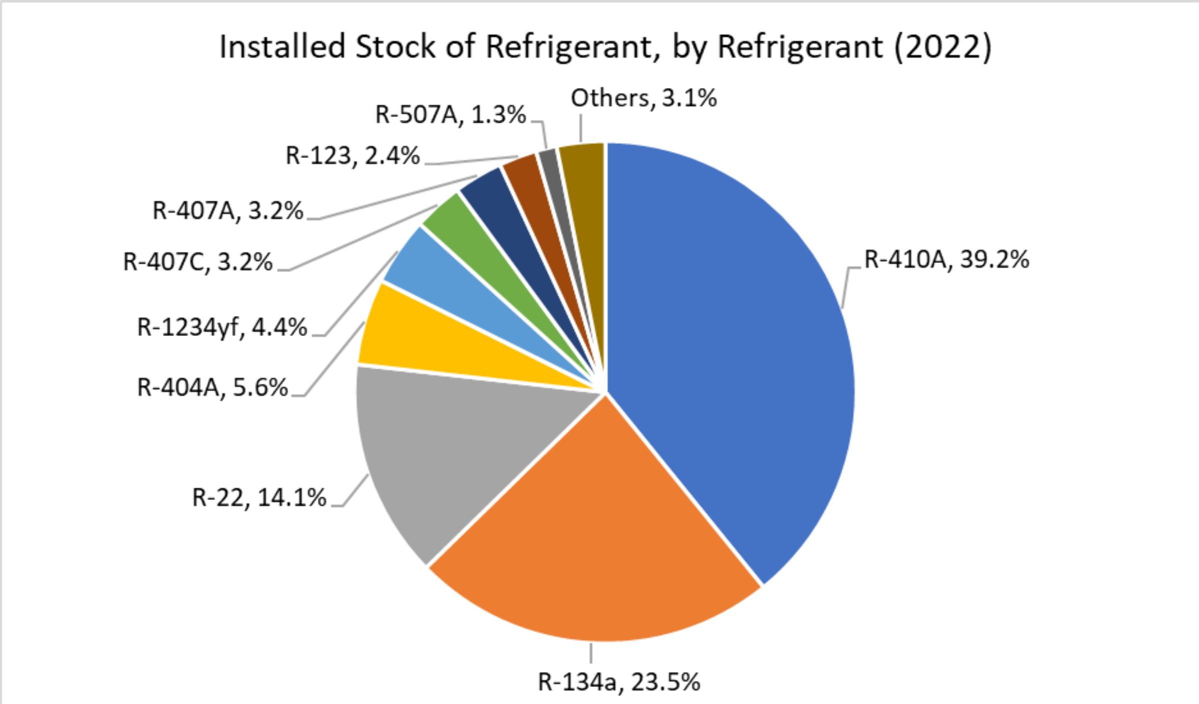
Figure 2. Installed stock of ODS and substitute refrigerants by category, by mass



The VM also provides estimates on the types of refrigerants (ODS and substitutes) that are in installed stock both within the RACHP sector and across the sector. Figure 3 shows the breakdown of installed stock of the most abundant refrigerants. The top three refrigerants in installed stock are R-410A (39 percent), R-134a (24 percent), and R-22 (14 percent). The following sections of this report provide additional, high-level information on each of the subsectors within the RACHP sector, including typical refrigerants used within these subsectors.

[22] Data pulled from VM IO file_v5.1_03.23.2022.

Figure 3. Installed stock of ODS and substitute refrigerants by refrigerant, by mass



4.1 Refrigeration Categories

There are four main refrigeration categories with estimates of installed refrigerant stock from the VM: IPR, domestic refrigeration, commercial refrigeration, and refrigerated transport.

4.1.1 Industrial Process Refrigeration

IPR accounts for the greatest amount of installed stock of ODS and substitute refrigerants among refrigeration categories. As the name implies, this category encompasses refrigerant use in the IPR subsector, but also tracks stocks of refrigerants in other subsectors, like cold storage warehouses. It accounts for 12.3 percent of the total installed stock across all RACHP categories, and over half (54.7 percent) among refrigeration categories. IPR systems are used to cool process streams in industrial applications and may involve complex and customized systems for a given application. Typically, the equipment and systems used in IPR have a large refrigerant charge size to accommodate for the significant cooling demands at a facility.

IPR equipment may use different refrigerants depending on the application (*e.g.*, the cooling demand needed). The most common ODS and substitutes used as refrigerants in the IPR category in the VM are R-22, R-134a, and R-404A, making up about three quarters of the installed ODS and substitutes. Beyond HFCs and ODS, other refrigerants such as ammonia (R-717) is also used in the IPR subsector (AHRI, 2019b).

4.1.2 Commercial Refrigeration

Commercial refrigeration accounts for 7.5 percent of the installed stock of ODS and substitute refrigerants among all RACHP categories. Among only refrigeration categories, commercial refrigeration accounts for about one third of the installed stock of ODS and substitute refrigerants. Commercial refrigeration includes a wide range of subsectors that depends on the specific uses of the equipment. Such subsectors may include stand-alone retail food refrigeration, supermarket systems, refrigerated display cases, refrigerated food processing and dispensing equipment, vending machines, automatic commercial ice makers, and more. Within these subsectors, there may be a variety of different types of equipment used. For example, equipment used in supermarket systems may be large and complex depending on the layout of the store and its geographic location. Refrigerated dispensing equipment may include products such as soft-serve ice cream machines.

Along with the variety of subsectors within commercial refrigeration, the amount of refrigerant charged in the equipment and the type of refrigerant used vary by application and use. The most common ODS and substitute refrigerants in installed stock in the commercial refrigeration subsector are R-407A, R-404A, and R-22 (collectively accounting for 87 percent of the installed stock of refrigerants in this subsector). As the industry transitions to lower-GWP refrigerants, there are many suitable substitutes depending on the subsector or application within commercial refrigeration. For example, some types of equipment in supermarket systems are using CO_2 (R-744) as a refrigerant (U.S. EPA, 2022b).

4.1.3 Domestic Refrigeration

Domestic refrigeration accounts for less than 2 percent of the total installed stock of ODS and substitute refrigerants among all RACHP categories. Of the refrigeration categories, domestic refrigeration accounts for nearly 8 percent. The domestic refrigeration category covers the subsector of residential applications of refrigeration equipment, including household refrigerators, freezers, and combination refrigerator/freezers. These types of equipment are intended for residential use but may be used outside of the home. Products with both a refrigerator and freezer (*i.e.*, combination refrigerator/freezer) are the most common. Other products included in this subsector may include chilled kitchen drawers and wine coolers.

Among ODS and substitutes, the most common refrigerant in installed stocks in domestic refrigeration in the United States is R-134a, accounting for about 89 percent of the subsector. Prior to the Montreal Protocol, R-12 was commonly used before most of the industry transitioned to HFC-134a for domestic refrigeration applications. According to the 2022 progress report from the Technology and Economic Assessment Panel

(TEAP) to the Montreal Protocol, isobutane (R-600a) is now used in 75 percent of all new units globally, with the remainder being R-134a.[23]

4.1.4 Refrigerated Transport

Refrigerated transport accounts for just under one percent of the total installed stock of ODS and substitute refrigerants among all RACHP categories and accounts for 4.2 percent of the total installed stock of ODS and substitute refrigerants in the refrigeration categories. The refrigerated transport category essentially is comprised of the refrigerated transport subsector, which generally includes the movement of perishable goods (*e.g.*, food) and pharmaceuticals at low temperatures (between -22 °F and 61 °F). Various modes of transportation take place within this subsector, including road, ships, and intermodal containers. The most common mode of refrigerated transport is via roads, which includes refrigerated vans, trucks, and trailer-mounted systems. Refrigerated transport via ship, or marine, includes transport of perishable goods via refrigerated ship and marine branches (*e.g.*, merchant, naval, fishing, cruise-shipping). Intermodal containers in refrigerated transport are refrigerated containers that allow uninterrupted storage during transport on different mobile platforms, including railways, trucks, and ships.

The most common ODS and substitute refrigerants in installed stock for refrigerated transport are R-404A (50 percent), R-134a (20 percent), R-507A (16 percent), and R-22 (10 percent). Recently, manufacturers have been designing equipment to use other substitute refrigerants, including R-744, R-513A, and R-452A. The type of refrigerant selected may depend on the application or mode of refrigerated transport. For example, a particular refrigerant may be selected depending on its cooling capacity or other properties, such as non-flammability.

4.2 Air conditioning Categories

There are three main air conditioning categories with estimates of installed refrigerant stock from the VM: residential and light commercial air conditioning; large commercial air conditioning; and MVAC.

4.2.1 Residential and Light Commercial Air Conditioning

Residential and light commercial air conditioning has the greatest estimated installed stock of ODS and substitute refrigerants among all RACHP categories at about 40 percent of the total. Among air conditioning categories, the residential and light commercial air conditioning subsector accounts for 55.3 percent. The category shares the same name of the subsector, and equipment used within this subsector include those for cooling individual rooms and single-family homes, small commercial unitary air conditioning systems, and packaged terminal air conditioners (PTAC). The equipment may contain self-contained or split systems. Self-contained systems may include

[23] The Technology and Economic Assessment Panel is an advisory body to the parties to the Montreal Protocol and is recognized as a premier global technical body; reports available at: https://ozone.unep.org/science/assessment/teap.

window air conditioning units, portable air conditioning units, and wall-mounted self-contained units. Split systems may include ducted and non-ducted mini-splits, VRF systems, and ducted unitary split systems.

R-410A accounts for the majority (85 percent) of the installed stock of ODS and substitute refrigerants in the residential and light commercial air conditioning subsector. The remaining installed stock in this subsector is primarily R-22 at 13 percent of the total. R-454B and R-32 have been emerging as possible substitutes for equipment using R-410A as industry is transitioning to lower-GWP refrigerants (Turpin, 2020).

4.2.2 Large Commercial Air Conditioning

Large commercial air conditioning accounts for 19.7 percent of the total installed stock of ODS and substitute refrigerants in the RACHP sector. Among air conditioning categories, large commercial air conditioning accounts for 25.5 percent of the installed stock of refrigerants. Large commercial air conditioning applications for stationary air conditioning include comfort cooling for larger buildings, such as offices, hotels, arenas, and more. Comfort cooling in these applications is often achieved using a chiller (*e.g.*, centrifugal or positive displacement). In commercial applications, centrifugal chillers may more often be used for higher cooling demands, while positive displacement chillers tend to be used for smaller capacity needs, like mid- and low-rise buildings.

The most common ODS and substitute refrigerants in installed stock in stationary air conditioning – large commercial are R-134a (38 percent), R-22 (21 percent), R-407C (16 percent), R-123 (9 percent), and R-410A (8 percent). The VM also shows estimates of installed stock of some lower-GWP refrigerants, including R-450A (4 percent) and R-513A (4 percent).

4.2.3 Mobile Air Conditioning

Mobile air conditioning accounts for 14.9 percent of the installed stock of ODS and substitute refrigerants in the overall RACHP sector. Among air conditioning categories, mobile air conditioning accounts for 19.2 percent of the installed stock of refrigerants. The mobile air conditioning category essentially comprises of the MVAC subsector and it includes systems that are used to cool the passenger compartment of light-duty vehicles, light-duty trucks, heavy-duty vehicles, school and tour buses, transit buses, and passenger rail vehicles.

There are two refrigerants that make up essentially all of the installed stock of ODS and substitutes in mobile air conditioning: R-134a (71 percent) and R-1234yf (29 percent). All of the estimated installed stock of R-1234yf are in the mobile air conditioning subsector. Much of the MVAC subsector is transitioning to using R-1234yf, particularly for light-duty vehicles. According to the 2023 EPA Automotive Trends Report, approximately 97 percent of model year 2022 light-duty vehicles sold used R-1234yf and some manufacturers have implemented R-1234yf across their entire vehicle brands (U.S. EPA, 2023c).

5. Reclamation Market for HFCs

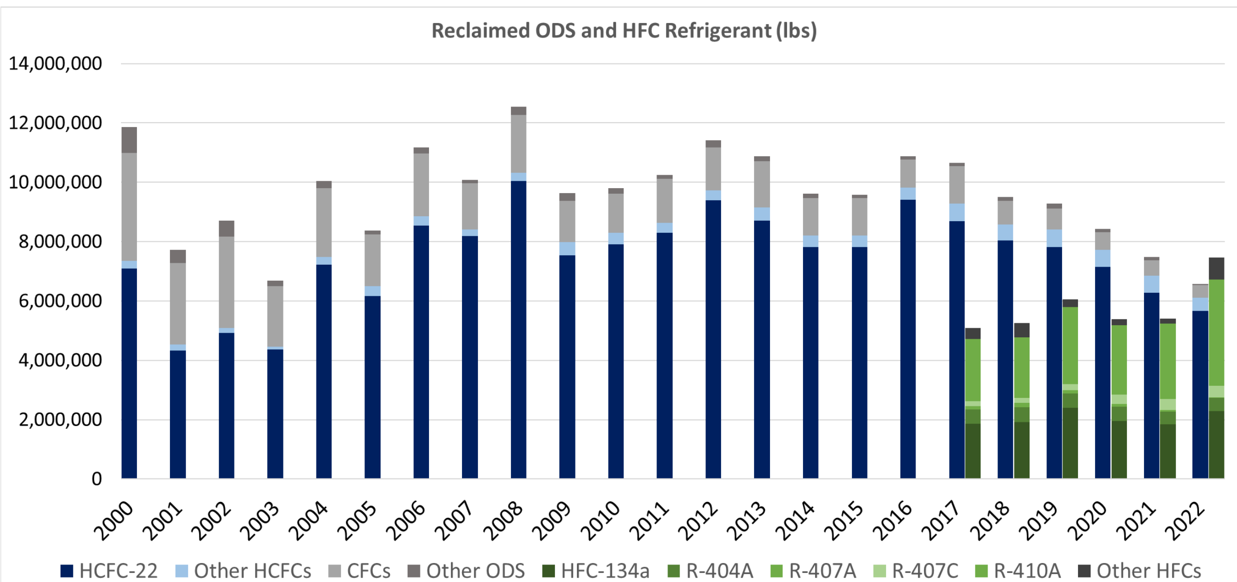
This section provides information on the reclamation market in the United States, beginning with a section on trends of the HFC reclamation market in the recent past and present, followed by an assessment of the anticipated demand of reclaimed HFCs in certain RACHP subsectors (Section 5.1). Section 5.2 describes the processes and methods of reclamation, including sources, equipment, and other aspects. Section 5.3 then presents cost drivers of reclaimed HFCs. Section 5.4 provides information on examples of incentives to recover and reclaim refrigerants.

5.1 HFC Reclamation Market

5.1.1 Past HFC Reclamation Trends

Figure 4 provides the total quantities of reclaimed substances since 2000, as reported annually to EPA by reclaimers per 40 CFR 82.164(d).[24] The figure shows data for certain ODS (*e.g.*, HCFCs, CFCs) and HFCs. ODS are shown in the stacked grey and blue columns and HFCs are shown in the stacked green columns. Reclaimers were not required to include HFC refrigerant in reports to EPA until 2017 (U.S. EPA, 2016b).

Figure 4. Reclaimed ODS and HFC Refrigerants from 2000 to 2022



After a relatively consistent upward trend between 2001 and 2008, reaching a peak of 12.55 million lbs, ODS reclamation was reasonably stable between 2009 and 2017, ranging between 8.39-11.32 million lbs per year. Since 2016, ODS reclamation quantities have decreased steadily by an average of 6.6 percent each year. HFC reclamation had remained relatively constant, between 5.09 and 6.06 million lbs from 2017 to 2021. In 2022, HFC reclamation had a notable increase to 7.47 million lbs,

[24] Refrigerant reclamation data as reported to EPA per requirements under section 608 of the CAA are current as of April 2024.

which is approximately 38 percent more than HFC reclamation in 2021. Further, 2022 is the first year that HFC reclamation totals exceeded ODS reclamation totals. The most common refrigerants containing HFCs (whether neat or in a blend) reclaimed in 2022 were R-410A (3.57 million lbs) and HFC-134a (2.28 million lbs) (Table 1). R-410A and R-134a were also the HFCs that saw the greatest increase in reclamation from 2021 to 2022 with increases of approximately 40 percent and 24 percent, respectively. The “Other HFCs” also saw a significant rise due to increased reclamation of particular HFCs.

Table 1. HFC Refrigerant Reclamation Reported Totals by Year (lbs)

Refrigerant	2017	2018	2019	2020	2021	2022
R-134a	1,858,132	1,910,240	2,399,952	1,956,644	1,844,793	2,284,655
R-404A	486,719	506,639	485,338	478,556	416,352	440,609
R-407A	111,255	143,254	105,435	87,162	60,580	22,777
R-407C	167,445	167,248	213,668	315,424	366,521	394,438
R-410A	2,103,404	2,043,667	2,596,861	2,347,000	2,550,164	3,573,420
Other HFCs	363,311	479,261	258,486	206,029	173,022	754,293
Total	**5,090,266**	**5,250,309**	**6,059,740**	**5,390,816**	**5,411,433**	**7,470,193**

As noted in section 2 of this report, the AIM Act assigns each regulated HFC with an exchange value. HFCs are potent GHGs that have a capacity to trap hundreds to thousands of times the amount of heat in the atmosphere relative to CO_2, as presented by each individual chemical’s GWP.[25] GWPs can be used to compare relative warming effects of GHGs in the atmosphere using a common unit, carbon dioxide equivalent (CO_2e), and often is presented in million metric tons CO_2e ($MMTCO_2e$).

To present the data in Table 1 in $MMTCO_2e$, the totals for each refrigerant were converted from lbs using GWPs that range from 1,430 (HFC-134a) to 14,800 (HFC-23). Subsection I of the AIM Act currently provides the full list of exchange values for regulated HFCs. Multiplying the respective GWP by the number of lbs of each HFC yields the exchange value in lbs. To obtain $MMTCO_2e$, the total exchange value in lbs was first divided by 2,204.6 (the number of lbs in a metric ton) and then divided by one million. Table 2 presents the total estimated reclaimed HFC refrigerants in $MMTCO_2e$.

As a reference for the size of the HFC reclamation market, EPA compared the annual amount of HFC reclamation total to the total annual consumption of HFCs in 2020. The total consumption[26] is calculated as the sum of the annual production and imports of HFCs minus the total HFCs destroyed and transformed. This total includes HFCs produced or imported for any use in any sector, including for RACHP equipment, foams, aerosol, or others, or could even have been imported by reclaimers for the purposes of rebalancing blends of reclaimed HFCs. The total consumption of HFCs in 2020 was 309

[25] See 42 U.S.C. 7675(c); see also Appendix A to Part 84 - Regulated Substances. As explained in the Allocation Framework Rule (86 FR 55116), EPA has determined these are the same as the 100-year GWPs listed in the 2007 Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report.

[26] For additional detail, see https://www.epa.gov/ghgreporting/ghgrp-data-relevant-aim-act.

MMTCO$_2$e (U.S. EPA 2022a). When comparing to annual HFC reclamation, the total amount of HFCs reclaimed in a given year (between 2017 and 2022) is equal to an amount that is approximately 2 percent of the total annual consumption in 2020.

Table 2. HFC Refrigerant Reclamation (in MMTCO$_2$e)

Refrigerant	2017	2018	2019	2020	2021	2022
R-134a	1.21	1.24	1.56	1.27	1.20	1.48
R-404A	0.87	0.90	0.86	0.85	0.74	0.78
R-407A	0.11	0.14	0.10	0.08	0.06	0.02
R-407C	0.13	0.13	0.17	0.25	0.29	0.32
R-410A	1.99	1.94	2.46	2.22	2.41	3.38
Other HFCs[a]	0.59	0.77	0.37	0.32	0.28	1.18
Total	**4.89**	**5.11**	**5.52**	**4.99**	**4.99**	**7.16**

[a] Other HFCs were calculated in MMTCO$_2$e using aggregated totals of each HFC reclaimed as reported during annual reporting per 40 CFR 82.164(d) and using their respective GWPs

It is expected that the HFC reclamation market will increase in future years as more RACHP equipment using HFC refrigerants reach their end-of-life, and more HFCs are potentially available for recovery and reclamation. In addition, virgin HFC supplies are restricted consistent with the AIM Act, and industry may look to reclaimed materials for servicing existing equipment.

5.1.2 Anticipated Demand for Reclaimed HFCs in Equipment in Certain RACHP Sectors

Under subsection (h) of the AIM Act, EPA is finalizing certain regulatory requirements[27] to address HFC management for RACHP equipment. For some subsectors EPA is finalizing the required use of reclaimed HFCs for the servicing/repair of existing equipment. In particular, these subsectors and requirements are as follows:

- supermarket systems;
- refrigerated transport; and
- automatic commercial ice makers.

EPA reviewed the estimated demand for HFCs for the servicing/repair of existing equipment in certain subsectors of the RACHP sector. Specifically, EPA reviewed the estimated demand for the covered subsectors with reclaim use requirements as finalized under the ER&R rulemaking under subsection (h) of the AIM Act using the VM. The model was assessed for estimated demand in 2029, as the compliance date for the Agency's requirements for using reclaimed HFCs would be January 1, 2029. Table 3 shows the anticipated demand for reclaimed HFCs in the covered subsectors for servicing/repair, respectively, that would be required to be met with reclaimed HFCs. The baseline demand for this analysis assumes that the ER&R rule and its associated provisions have gone into effect.

[27] See docket EPA-HQ-OAR-2022-0606.

Table 3 provides estimates of the demand for the servicing and/or repair of existing equipment in the covered subsectors in 2029, by refrigerant type for selected refrigerants that contain HFCs (whether neat or in a blend). Again, the selected refrigerants are those, in general, commonly used today in the covered subsectors in the RACHP sector. As Table 3 shows, however, the estimated demand for the supermarket systems and refrigerated transport subsectors is greater. These subsectors will have a greater need for reclaimed refrigerants containing HFCs for use in existing equipment so they can be used throughout their remaining useful life. Compared with existing equipment, new equipment is more likely to be transitioning to other refrigerants, whether that be other HFCs or blends containing HFCs (not included in Table 3), or substitute refrigerants that do not contain HFCs (*e.g.*, HFOs, ammonia, hydrocarbons).

The subsector with the greatest anticipated demand of HFCs for servicing and/or repair in existing equipment in 2029 is supermarket systems. Supermarket systems account for approximately 69 percent of the total anticipated demand of HFCs for servicing and/or repair in 2029. This is likely a result of a few factors assumed in the Vintaging Model for this subsector, including a high average leak rate for equipment and large charge sizes of equipment. The refrigerant blend containing HFCs with the highest anticipated demand for servicing and/or repair in 2029 is R-407A (all anticipated use in supermarket systems) followed by R-404A (anticipated use in supermarket system, refrigerated transport, and automatic commercial ice makers).

Table 3. Estimated demand for servicing and/or repair (lb) for the covered RACHP subsectors in 2029

Service Demand (lbs)	HFC-134a	R-404A	R-410A	R-507A	R-407A	R-407C	R-450A/ R-513A	R-448A/ R-449A	R-452A	Total
Supermarket Systems		5,017,210		132,386	13,942,072					19,091,668
Refrigerated Transport	1,479,666	3,073,125	134,301	1,344,265		35,124	17,461		2,134,922	8,218,863
Automatic Commercial Icemakers	22,862	68,564						99,473		190,898
Total	1,502,528	8,158,899	134,301	1,476,651	13,942,072	35,124	17,461	99,473	2,134,922	27,501,429

The estimated demands for servicing and/or repair of equipment in Table 3 for common reclaimed HFC refrigerants (neat or in blends) can be compared to the totals of reclaimed HFC refrigerants in Table 1. As can be seen, the anticipated demand for reclaimed HFCs in 2029 is generally greater than the total amount of HFCs reclaimed in any year where reclaimed HFC data have been reported.

Additional reclaimed capacity will be required to meet the anticipated demands for using reclaimed refrigerants containing HFCs (neat or in a blend). Further, Table 3 provides the demand for these common blends and refrigerants; however, there is additional demand for other HFCs in 2029 in these subsectors, both neat and as they are used in blends.

5.2 Reclamation Methods and Processes

In 2010, EPA commissioned an analysis of the state of the reclamation industry (Stratus Consulting 2010). For the study, several reclaimers, one industry organization, one laboratory, and four air conditioning and refrigeration equipment manufacturers were interviewed.

Additionally, EPA interviewed reclaimers between 2018 and 2019 on the reclamation industry as a whole, their role in the reclamation industry, and the reclamation methods and processes they performed. EPA hosted a public reclamation workshop in 2021 to provide general information on the AIM Act and reclamation, as well as open discussion on preliminary questions. Further, EPA held stakeholder meetings in November 2022, March 2023, and April 2023. These stakeholder meetings sought feedback related to the development of the proposed rule under subsection (h) of the AIM Act, while also providing focus on specific topics related to reclamation. EPA heard feedback on potential barriers to reclamation, as well as technical capabilities that were detailed in the draft version of this report that was issued with the NODA in October 2022.

EPA is also aware of a report produced in 2022 by a group of eNGOs that provides information and research on “Life Cycle Refrigerant Management,” which includes increasing opportunities for reclamation of HFCs (NRDC et al., 2022). The report highlights the importance of reclamation of HFCs to supporting the overall phasedown of HFCs under the AIM Act, since some HFCs will continue to be needed to support the servicing of existing equipment. Further, HFCs are being phased *down*, not phased *out* like ODS, indicating the recognized need for HFCs for certain uses. The report also describes the reality that the reclamation of HFCs currently does and will continue to require more sophisticated separation technologies to purify complex mixtures of refrigerant gases that are returned to reclaimers. Other challenges and opportunities for increasing reclamation are described in the report, such as the need to increase the amount of refrigerant recovered and returned to reclaimers and exploring options for requiring the use of reclaimed HFC refrigerant in certain new or existing equipment.

The 2010 study found that the reclaimers mix-and-match quantities of refrigerant from different cylinders to produce bulk batches that meet or exceed a given overall purity level. The objective is to maximize the amount of recovered refrigerant while minimizing the energy required to return each batch to the required purity level (*e.g.*, 99.5 percent). The study also found that reclaimers’ business operations determined their reclamation methods. A small reclaimer that only processes small batches of almost pure HCFC-22 might use different processes than a large reclaimer that processes large batches of refrigerant with a higher proportion of mixed gas. For example, smaller reclaimers may rely more on “off-the-shelf” systems that have limited technical capacity and throughput. A larger reclaimer may have the ability to process a greater capacity of recovered materials and may use a more complex and/or customized system to reclaim (*e.g.*, via distillation).

Based on information available to EPA, including those listed above, the following sections of this report discuss the sources of recovered refrigerant (Section 5.2.1), equipment used in reclamation (Section 5.2.2), the use of virgin gas by reclaimers (Section 5.2.3), how much refrigerant they stockpile at any given time (Section 5.2.4), and the reclamation of HCFC-22, specifically (Section 5.2.5).

5.2.1 Sources of Recovered Refrigerant

Reclaimers obtain recovered HFCs for reclamation through a number of means:

- Refrigerant wholesalers or distributors that collect recovered refrigerant as a service to contractors,
- Contractors/technicians who recover refrigerants and send materials to reclaimers,
- Scrap metal recycling yards that recover refrigerant from small appliances and MVACs before shredding, and
- Owner/operators of large appliances such as chillers and supermarkets. (U.S. EPA 2021a)

The 2010 study found that recovered refrigerant comes from numerous sources. Most often, reclaimers received recovered refrigerant indirectly from wholesalers who accepted cylinders as a service to technicians. Less frequently, the refrigerant came directly from technicians who dropped it off at reclaimers’ facilities (Stratus Consulting, 2010).

Similarly, from past interviews in 2018 and 2019, EPA understands that reclaimers may receive recovered refrigerant from a variety of locations. Based on these interviews, EPA understands that some reclaimers receive recovered refrigerant primarily from RACHP contractors and technicians (both small and large), while others primarily work with wholesalers. EPA learned that one reclaimer receives recovered HFCs from supermarkets, chillers, and ice rinks, and that another reclaimer provides reclamation/recycling as a side service for their customers.

Additionally, EPA understands that reclaimers that primarily work with wholesalers may be less aware of the original application of the recovered refrigerant. Those that recover their own materials or work closely with contractors and technicians may have more information on the original application in which the recovered refrigerant was used. For example, based on the interviews in 2018 and 2019, EPA understands that a common source of recovered HFC-134a for some reclaimers is from residential refrigerators. EPA also learned that one reclaimer that does on-site recovery maintains a database for the source of all of their recovered refrigerant.

5.2.2 Equipment Used in Reclamation

Based on the 2010 study, reclaimers first weighed the cylinder (to determine the volume of refrigerant inside) and determined the contents of each cylinder, generally using a hand-held gas analyzer (*e.g.*, a Neutronics refrigerant analyzer). If the contents appeared to be mixed, the reclaimer sometimes used a gas chromatograph (GC) to determine the container's contents in more detail. The study found distillation to be the most common primary separation method for reclamation systems. Other methods may include adsorption/desorption, cryogenic subcooling, and other processes used to address the different specifications established in appendix A to 40 CFR part 82, subpart F (Stratus Consulting, 2010).

According to the 2010 study, the typical reclamation process uses one of three pieces of equipment/technologies: a compressor for distillation, adsorbent beds for adsorption/desorption separation, or cryogenic filters to cool the refrigerant (Stratus Consulting, 2010). Among these separations, distillation is the most common primary separation method for reclamation systems, and larger reclaimers are more likely to have this capability.

- In a compressor-based distillation system, a compressor is used to increase the pressure of the refrigerant to use ambient air to condense the refrigerant.
- In an adsorption/desorption system, the contaminated refrigerant enters an initial adsorption chamber where the refrigerant is adsorbed to an adsorbent bed; impurities are not adsorbed in this chamber and continue to a second chamber, from which they are discharged. After the impurities have been isolated, the refrigerant can be desorbed from the adsorption bed and collected from the system.
- In a cryogenic subcooling system, dirty refrigerant is cooled in three stages. The refrigerant is then sent through cryogenic filtration with coalescent filters to remove most small particles. In the last step, a microprocessor-controlled purge device releases the non-condensable substances.

The type of equipment used in the industry can vary considerably and may depend on factors such as the size of the reclaiming operation and the amount of refrigerant that the reclaimers are handling. Smaller operations typically use "off-the-shelf" equipment, while larger operations purchase or manufacture custom equipment. Off-the-shelf equipment are pre-designed systems that are sold to be used for the reclamation of recovered refrigerants. These off-the-shelf models were limited in terms of capacity and speed (2-5 lbs per minute). EPA further learned from interviews in 2018 and 2019 that refrigerants may require multiple cycles through off-the-shelf equipment to get a clean result with an acceptable refrigerant purity and may have difficulties when processing recovered refrigerants that were mixed. Off-the-shelf equipment are likely more applicable to the reclamation of ODS, where recovered gases are not typically in complex mixtures with other types of refrigerants, which is more common for refrigerants containing HFCs.

Large-scale operations typically do not use off-the-shelf equipment because they are not capable of handling larger volumes of refrigerants. Larger reclaimers use customized equipment that can handle more refrigerants and provide a higher degree of accuracy when processing refrigerant blends. Among the reclaimers interviewed by EPA in 2018 and 2019, many used custom-built equipment and a GC. At least two reclaimers who were interviewed have separation towers and at least two used fractional distillation to separate mixed gas. In comments submitted on the ER&R rule, one reclaimer stated that they "currently use fractional distillation to separate R-32 from recovered refrigerant blends, most notably R-410A and R-407 variants. This ensures a level of purity that meets or exceeds the AHRI-700 standard for the product" (A-Gas, Inc 2023).

Additional analytics first test the refrigerant that has been recovered in addition to testing for purity specification after processing. Mixed refrigerants and multi-component blends may require complex fractional distillation, where the recovery of single-component refrigerants (more common with ODS) could be a simpler separation process. The increase in mixed refrigerants returned for reclamation and the use of refrigerant blends have led to more complex reclamation systems. The U.S. reclamation industry is transitioning from simpler ODS reclamation technologies to more sophisticated fractional distillation for HFCs (NRDC et al., 2022). One reclaimer noted that, as a technical matter, "no mix of gases is so mixed as to be beyond the ability of fractional distillation equipment to separate."[28] While this may be the technical case, refrigerant gases that are highly mixed could require more complex processing and the decision to reclaim or destroy the mixed refrigerant would likely consider costs.

There is some new and ongoing research into techniques for separating HFC refrigerant mixtures into their constituent refrigerants. Some of these new techniques include (Shiflett Research Group, n.d.):

- Ionic liquids: the unique properties of ionic liquids (no measurable vapor pressure, dissolution of many organic and inorganic compounds, variable solubility of gases and liquids, and high thermal, chemical, and electrochemical stability) can be used in many separation and purification processes, such as HFC separations.
- Membranes: membranes are a barrier that selectively allows the passage of some species while preventing the passage of others. It is possible to design membranes capable of separating difficult HFC blends while potentially requiring less energy and capital.
- Porous media: porous media include nano- to micro-sized materials that can be exploited for their molecular sieve capabilities and chemical properties to conduct difficult separations of HFC mixtures.

[28] See https://www.regulations.gov/comment/EPA-HQ-OAR-2022-0606-0009.

5.2.3 Use of Virgin Gas

As noted in section 5.2.2 of this report, companies may use separation processes (*e.g.*, fractional distillation) to separate out impurities and other components (*e.g.*, oils, contaminants) from the recovered refrigerant to ensure that the refrigerant meets purity specifications, such as AHRI Standard 700-2016. Based on conversations with reclaimers, fractional distillation and other technologies allow companies to separate refrigerant blends without the use of virgin gas. However, some reclaimers note that these technologies are less economical and more energy intensive than blending (Hudson Technologies Company, 2021). Although entities can meet the purity standards through distillation by separating out other components from the desired final material, EPA's reclamation requirements under CAA section 608 do not require entities to have any particular purification technology. As the HFC phasedown progresses, access to virgin material to facilitate reclamation through blending will likely decrease. This increases the importance of separation and distillation technologies, as well as better practices during maintenance and recovery to avoid refrigerants being mixed.

Several refrigerant reclaimers submitted comments[29] to EPA during the public comment period for the Allocation Framework Rule (86 FR 27150) and additional comments were submitted in response to the NODA[30], indicating that virgin stock was necessary to meet AHRI Standard 700-2016, particularly if blending processes were used (*e.g.*, A-Gas, Inc. 2021, Hudson Technologies Company 2021). In their public comments, reclaimers noted that the reclamation of HFC blends may also require balancing, which necessitates the addition of one or more virgin refrigerants to the process (*e.g.*, Golden Refrigerant 2021, Hudson Technologies Company 2021). EPA responded to these public comments in finalizing the Allocation Framework Rule in 2021 (86 FR 55116). EPA noted that virgin HFCs are important during the reclamation process for rebalancing particular blends of HFC refrigerants. The 2022 report by the group of eNGOs states that virgin or otherwise pure (*e.g.*, other reclaimed HFCs) are generally used to rebalance specific ratios, but should not be used to dilute out impurities to reach the required purity standard (NRDC et al., 2022)

CARB finalized a regulation effective January 1, 2022, that defines "certified reclaimed refrigerant" as containing no more than 15 percent virgin refrigerant by weight and the certified reclaimer must provide supporting documentation showing as such (17 CCR § 95371-95379 2021). CARB arrived at a maximum allowable amount of virgin HFCs of 15 percent by weight in "certified reclaimed refrigerant" based on feedback from multiple stakeholders (including reclaimers, OEMs, and industry trade groups) who commented that having an allowable amount of virgin HFCs in reclaimed HFCs would be necessary for rebalancing out-of-ratio recovered HFCs and HFC blends (CARB, 2021).

For reclaimers who do not have distillation capacity, or for which distillation is not cost-effective, the throughput of refrigerant reclamation may be proportional to the amount of virgin materials they can access and the purity of the recovered refrigerants they receive. Under the Allocation Framework Rule, reclaimers that historically imported

[29] Docket ID No. EPA-HQ-OAR-2021-0044.
[30] See https://www.regulations.gov/comment/EPA-HQ-OAR-2022-0606-0003.

HFCs received allowances from the general pool. EPA also established a process under which eligible entities, including but not limited to reclaimers, could receive allowances, even if they did not historically import HFCs (*i.e.*, new market entrants). Some reclaimers received HFC consumption allowances in 2022 and 2023 as a result of either being previous importers of HFCs or through the new market entrant process.

From interviews with reclaimers in 2018 and 2019, EPA understands that some of the larger refrigerant reclaimers may also operate a refrigerant “banking” system, where they establish a price market for reclaimed refrigerant sold under their own brand name. In these cases, it is possible that an HFC producer or importer would be in direct competition with a reclaimer, although it is unclear the prevalence of this scenario or whether there are significant price disparities between virgin and reclaimed products for different refrigerants. For smaller refrigerant reclaimers, who function as a pass-through cost and may not directly sell their reclaimed refrigerant back to the market, there may be less likelihood of direct competition with HFC importers or producers.

5.2.4 Refrigerant Stockpile

Information on the amount and type of refrigerants stockpiled by reclaimers is limited. In the 2010 study, reclaimers noted that they did not believe stockpiling refrigerants was common.[31] Per recordkeeping and reporting requirements under AIM Act regulations (40 CFR 84.31), reclaimers are required to maintain records of the names and addresses of the persons sending them material for reclamation; however, they are only required to report the total mass of material received for reclamation. Thus, reclaimers are not required to report whether the reclaimed refrigerant came from a stockpile or from a recent field recovery. In interviews EPA had with reclaimers between 2018 and 2019, one reclaimer stated that they store some R-410A until prices are at the level at which it can profitably be reclaimed. As described in section 2 of this report, with the exception of a small allocation of allowances for R-123 and R-124, whose use is limited to servicing certain equipment, production and consumption of virgin ODS, including ODS refrigerants, have been phased out in the United States. Reclamation of HCFC refrigerant does not offset the production of HCFCs but provides another way for HCFC refrigerant to enter the market. EPA’s intent has always been to facilitate a smooth transition to substitutes, which includes avoiding stranding equipment that has not yet reached the end of its useful life. For example, although certain restrictions apply to the use of class II substances under section 605(a) of the CAA, used R-22 that is recovered and reclaimed, or virgin material produced before the 2020 phaseout, may continue to be used for as long as it is available to service refrigeration and air-conditioning equipment existing as of January 1, 2020. In this example, the availability of reclaimed R-22 refrigerant may lower the market price of R-22 refrigerant because reclaimed refrigerant helps supplement a limited supply of virgin refrigerant that can no longer be produced. This would reduce the perceived notion of a shortage and reduce the incentive for largescale stockpiling. EPA learned in interviews in 2018 and 2019 that some reclaimers use a “refrigerant bank” model that allows users to return recovered

[31] Reclaimers contacted for that study were running smaller operations and may not have been able to afford to keep a large inventory of refrigerants.

refrigerant and be guaranteed a similar quantity of refrigerant for a set price. This provides security to consumers on the availability of ODS refrigerant, which can reduce the need to stockpile it.

In the public comments to the Allocation Framework Rule, one reclaimer stated that there are limited data on virgin HFC stockpiling, including the size of such stockpiles (A-Gas, Inc., 2021). Additionally, other stakeholders asserted that although there are surplus HFC stockpiles in the marketplace, they saw no evidence of this in the market data. They said that if there were actual HFC stockpiles, they would expect companies to sell them at an incentivized price to make a large profit, which is not happening (FluoroFusion Specialty Chemicals, Inc., 2021, Kivlan and Company, Inc., 2021).

Data on imports of HFCs in 2021 suggests an increase in stockpiling across those with consumption allowances, which includes some reclaimers (as noted in section 5.2.3 of this report). Imports increased by over double from 2020 to 2021 (U.S. EPA, 2022a). It is expected that imports may have seen increases as significant steps begin to draw near in the phasedown schedule as required by the AIM Act (for example, a 40 percent reduction in 2024). While not all importers are reclaimers, reclaimers that do import may also be using their consumption allowances to stockpile virgin HFCs for future use in rebalancing reclaimed HFC refrigerants. Stockpiling may also occur related to the current market price of particular HFC refrigerants. Reclaimers may hold recovered material until the market is favorable to reclaim and sell the HFCs.

5.2.5 Reclamation of R-22

As a result of a variety of restrictions on R-22 under title VI of the CAA, including restrictions on HCFC production, consumption, and use, stockpiles of virgin R-22 refrigerant have been shrinking over the past few years. R-22 that is recovered and reclaimed, along with R-22 produced prior to 2020, will help meet the needs of owners of existing R-22 systems. To return recovered R-22 refrigerant to purity specifications, reclaimers often blend reclaimed HCFC-22 with virgin R-22. In some cases, R-22 that cannot be reclaimed onsite may be sent to other reclaimers that have the necessary technology to improve the purity (*e.g.*, distillation). In interviews with reclaimers in 2018 and 2019, one reclaimer noted that in the last few years, the price has become too expensive to use virgin R-22 to return the recovered R-22 to specifications through blending. According to reclaimers, some refrigerant in the market that is being reclaimed is not pure enough to process without separation. With no additional production or import, remaining stocks of virgin HCFC-22 are not available in sufficiently large quantities to blend with recovered gas, so R-22 outflows are now exclusively from reclaimed refrigerant. R-22 is still being reclaimed and is still expected to be reclaimed for the foreseeable future as long as there is eligible R-22 equipment in the field needing refrigerant for servicing.

5.3 Reclamation Cost Drivers

Proper refrigerant reclamation incurs a variety of costs borne by various parties throughout the refrigerant value chain. The overall reclamation cost may include cleaning the refrigerant, mixed gas separation, laboratory testing, and repackaging, in addition to sales and overhead expenses. The following sections of this report qualitatively describe costs borne throughout each stage of the reclamation process.

5.3.1 Recovery at End-of-Equipment Life

The reclamation process begins with contractors dispatched to site locations who recover refrigerant from decommissioned equipment. Contractors incur upfront costs for refrigerant recovery equipment, including recovery machines, refrigerant recovery cylinders, and field tests for moisture and contamination. As refrigerant recovery takes time, there can be an opportunity cost for contractors to properly recover all refrigerants (per EPA's regulations under CAA section 608) as opposed to illegally venting refrigerant. It is unclear whether any such opportunity costs are significant compared to the overall cost of a typical installation, and whether contractors typically pass along those costs to consumers in the form of hourly rates. Contractors also often bear any costs associated with transporting refrigerants to a distributor or reclaimer site. These costs may be more pronounced in rural areas or areas with low concentrations of refrigerant-containing equipment, as more travel is required per volume of refrigerant.

In other cases, small appliances and MVAC may be disposed of by an end user and may ultimately end up for final processing at a scrap recycler or landfill. Per regulations in 40 CFR 82.155, the final processor must properly recover any remaining refrigerant from appliances, or the final processor must receive a signed verification that the refrigerant in the appliance has been properly recovered prior to delivery. In the case where the refrigerant is not recovered prior to delivery, operators at landfills or scrap yards may encounter challenges in recovering the refrigerant due to limited training. Further, these entities may not have direct relationships with other steps of the reclamation supply chain. While the collective amount of refrigerant able to be recovered from small appliances and MVACs is significant, each individual scrap recycler or landfill operator likely recovers small quantities of refrigerant, limiting the economic benefit to the individual business of recovering the refrigerants.

5.3.2 Handling before Reclamation

Typically, contractors who recover used refrigerant will return the refrigerant to a distributor or wholesaler, who in turn will aggregate the refrigerant and interact with reclaimers. In these cases, the costs for storage and management may fall on the distributor or wholesaler. Larger contractors with the capability to store and catalogue volumes of refrigerants may work directly with a refrigerant reclaimer to return recovered refrigerants and to buy back reclaimed refrigerants. In these circumstances, the contractor bears the costs associated with storage and management. As the variety of different refrigerants being reclaimed increases, it is expected that storage and management costs will also increase. These anticipated cost increases account for additional refrigerant cylinders, more complex labeling and tracking, and any special equipment or handling required for processing flammable refrigerants.

5.3.3 Reclamation Costs

Refrigerant reclaimers must make significant capital expenditures to purchase the equipment required for testing refrigerant composition, removing impurities and waste products to meet the necessary purity standards, and altering blend compositions to be within required specifications. Section 5.2.2 of this report describes the equipment used for refrigerant reclamation in greater detail. These capital expenditures are typically amortized across the lifetime of the equipment. For higher-complexity refrigerant blends, it is likely that equipment costs are higher as there are more steps required for component separation, mixing, and testing. For example, fractional distillation requires both distillation expertise and capital investment (NRDC et al., 2022).

There are also various operational costs for refrigerant reclamation, including electricity to the reclamation equipment as well as labor costs to run the reclamation equipment and perform quality assurance checks. Some portion of the recovered refrigerant may be lost during the reclamation process; refrigerant reclaimers may purchase quantities of virgin refrigerants for the purpose of rebalancing reclaimed HFCs to achieve proper compositions. The cost of these purchases will vary depending on the quantity required and the price of the virgin refrigerant. Some refrigerant reclaimers also directly re-sell reclaimed refrigerant, in which case they assume marketing and administrative costs. In many cases, reclaimers will simply collect a pass-through toll from wholesalers to reclaim their refrigerants. In this scenario, the wholesaler will bear the costs associated with resale of the reclaimed refrigerant to equipment manufacturers and/or contractors.

Other logistical costs may also be considered as factors to reclamation, such as transporting recovered materials. It may not always be the case that when technicians recover refrigerants that they are located near a reclamation facility. The costs and time required to transport materials may be significant and possibly prohibitive depending on who in the supply chain bears the costs. Some reclaimers offer services to recover refrigerant on-site and may even offer buy-back incentives for certain types of refrigerants (*e.g.*, Hudson Technologies Company n.d., A-Gas, n.d.). Even still, ready access to these services may be geographically dependent.

5.4 Reclamation Incentives

At the time of the 2010 study, many reclaimers established incentive programs to encourage technicians and wholesalers to turn in recovered HCFC-22. Some reclaimers noted that EPA could maximize the amount of refrigerant entering the market by requiring technicians to report additional information on the amount of refrigerant that the technicians recover and where the recovered refrigerant goes after it leaves the technicians (Stratus Consulting, 2010).

During interviews EPA conducted with reclaimers between 2018 and 2019, the Agency learned about different incentives for HCFC-22 reclamation. EPA understands from these interviews that some reclaimers offer financial incentives and at least one does not. EPA also learned that one reclaimer offers financial incentives to wholesalers and strongly encourages them to share the incentive with their contractors. Another reclaimer has incentives that may shift over time based on prices. Further, EPA learned that reclaimers use various business models for the reclamation process. Some reclaimers operate as a "tolling" system (*i.e.*, the entity bringing in the recovered refrigerant pays a pass-through fee to account for reclamation and disposal, and then receives a matching volume of reclaimed refrigerant available for reuse on the market). Other reclaimers operate as a "banking" system, where contractors and wholesalers deposit recovered refrigerant and retain the title to a matching volume of reclaimed refrigerant that can be withdrawn later. Reclaimers who typically sell the banked refrigerant on the open market will use their own branding, excluding patented blends.

Beyond those programs discussed and known buyback programs from some reclaimers as discussed in section 5.3.3 of this report, EPA heard feedback to the NODA and in stakeholder meetings hosted for development of the proposed rule under subsection (h). Stakeholders expressed interest in the development of a type of incentive program to encourage additional recovery of HFC refrigerants to support the need for increased reclaim capacity. In general, some reclaimers have noted that they tend to pay for refrigerant returned to them for reclamation as refrigerant (both virgin and reclaimed) prices tend to increase with the progression of the phasedown of virgin HFCs.

5.4.1 Differences in Reclamation Incentive/Credit Programs

Several countries have set up refrigerant recovery and reclamation programs that establish prices and policies for incentives and credits. For example, in Australia, the industry-funded organization Reclaim Refrigerant Australia (RRA) recovers, reclaims, and destroys ODS and synthetic GHG refrigerants by placing a shared responsibility for end-of-life product management on producers or other entities in the supply chain. RRA establishes a levy system on imports for which the levies are then used to pay for rebates to refrigerant wholesalers, technicians, and contractors for recovering, handling, and returning refrigerants (RRA, 2019).

The United States currently does not have a national incentive or credit-based recovery and reclamation program, such as a national refrigerant bank or specific crediting scheme for reclamation. Individual wholesalers and reclaimers that wish to offer such incentives would need to develop their own credit programs to incentivize the return of recovered refrigerant, as they may see fit. As the RACHP sector transitions to lower-GWP substitute refrigerants, it may become more difficult for individual wholesalers and reclaimers to accurately forecast prices for various refrigerants, which may reduce the feasibility of establishing incentive/credit programs for refrigerant recovery.

6. Safety of Technicians and Consumers

RACHP technicians are typically trained and, at minimum, required to have the appropriate certification under 40 CFR 82.161 for the equipment that they maintain, service, repair, or dispose of. While the process for recovering lower-GWP refrigerants will be similar to those in wide use today, technicians must be mindful of substitute refrigerants that carry flammability risks. As described in this section, the RACHP sector is currently preparing technicians to be knowledgeable of safe procedures to handle flammable refrigerants, which presents a change in historical refrigerant recovery and handling practices. Consumers are generally not involved in the refrigerant recovery process and should not experience any safety issues if technicians follow industry guidance and EPA requirements per 40 CFR part 82 on proper recovery procedures.

Under EPA's regulations implementing CAA section 608, all persons who could reasonably be anticipated to violate the integrity of the refrigerant circuit during maintenance, service, repair, or disposal of appliances that contain ODS, as well as those containing non-exempt substitute refrigerants, such as HFCs, are required to meet certification requirements (40 CFR 82.161). Under regulations per CAA section 609, no person who repairs or services a MVAC or MVAC-like appliance may perform any service involving the refrigerant for the MVAC or MVAC-like appliance unless they properly use approved equipment and are trained and certified by an EPA-approved organization (40 CFR part 82, subpart B).

Certain substitutes to HFC refrigerants, including higher flammability (*e.g.*, A3; R-600a), lower flammability (*e.g.*, A2L; R-454A), and higher toxicity (*e.g.*, B2L; R-717) refrigerants, are likely to enter the market as the transition to lower-GWP refrigerants progresses. See Table 4 for the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) classification of refrigerant flammability and toxicity (ASHRAE, 2019). Widespread use of A2L, A3, and B2L refrigerants may require additional training for service technicians to ensure safe handling when equipment using those refrigerants need servicing or require end-of-life recovery.

There may be other safety considerations when dealing with flammable refrigerants. EPA heard in our public workshop in 2021 that there should be considerations for the safe transport of flammable refrigerants like A2L refrigerants and treatment of these refrigerants under other regulation. EPA further heard in the stakeholder meeting in November 2022 of the importance of continuing to train technicians as new refrigerants are entering the market and becoming more common. For example, refrigerants that exhibit the hazardous waste characteristic of ignitibility per 40 CFR 261.21 may need to be managed as hazardous waste under the Resource Conservation and Recovery Act (RCRA).

Table 4. ASHRAE Refrigerant Designations

Higher Flammability	A3	B3
Lower Flammability	A2	B2
	A2L	B2L
No Flame Propagation	A1	B1
	Lower Toxicity	**Higher Toxicity**

Source: ASHRAE (2019)

7. Barriers and Key Challenges to Greater Refrigerant Recovery and Reclamation

There are barriers and key challenges that technicians, wholesalers, reclaimers, and other market actors have raised for consideration in order to increase the amount of refrigerant that is recovered and reclaimed for refrigeration and air conditioning systems. Barriers and challenges such as rising costs of reclaiming, market fluctuations, increased blends and mixed gases, and increased technological demands have led to a lack of incentivization to reclaim refrigerants. However, more recent price dynamics for HFCs may be changing historic trends.

7.1 Contamination and Accommodating Blends and Mixed Cylinders

From interviews with reclaimers in 2018 and 2019 and comments received in response to the NODA in October 2022, EPA understands that one of the biggest challenges in the reclamation industry is dealing with mixed refrigerants or a recovery cylinder containing multiple types of refrigerants, an issue that may become more common with the increase in the variety of refrigerants being used. EPA understands that with the RACHP sector's transition to lower-GWP substitutes, there will be a greater variety of refrigerants on the market. For example, technicians recovering refrigerant may inadvertently recover R-410A in a cylinder containing R-22 or may knowingly do so if there is no other recovery cylinder available. RACHP technicians servicing residential and light-commercial air conditioning equipment may need to carry multiple cylinders for the refrigerant used to service equipment (*e.g.*, new) or any refrigerant that is recovered, including R-22, R-410A, R-134a, R-32, and R-454B. Additionally, many lower-GWP refrigerants consist of multi-component HFC/HFO blends, which require additional steps to reach purity specifications and proper refrigerant compositions and are more difficult to separate than blends with only two components. Other lower-GWP refrigerants also carry flammability risks, which may increase costs and safety processes. To ensure the maximum value for recovered refrigerants, technicians would likely have to increase the number of cylinders they carry to prevent mixing refrigerants.

During interviews in 2018 and 2019, EPA learned of potential issues with mixed gases from the residential air conditioning sector, specifically the lack of proper maintenance or the reuse of gas from one job to the next, which leads to contamination. Further, EPA understands from these interviews that "topping-off" systems occurs when original refrigerants have not first been evacuated, which contributes to contaminated refrigerants that would be available for recovery.

Reclaiming mixed-refrigerant cylinders may incur increased time and difficulty to determine the precise composition of gases in the cylinder, separate the various component gases, and then return each component to the specified composition. From EPA's public workshop in 2021, the Agency understands that blends and mixed refrigerants can be problematic, and that reclaimers who are unable to perform the required processing may decide to destroy the returned refrigerant rather than incurring additional costs. As noted in previous sections of this report, sophisticated fractional distillation is required to separate and reclaim highly mixed refrigerants, which requires technical expertise and high capital costs.

Some reclaimers will blend virgin refrigerant, which can be combined with mixed recovered refrigerant, to increase the purity as a cost-effective option over the process of using a fractional distillation column. As the phasedown of virgin HFCs progresses, however, this will become a less feasible option. Further, EPA understands the need for virgin HFCs to rebalance reclaimed HFCs to achieve appropriate ratios of blends of HFCs. Blending up as the sole method of achieving the purity standard for reclaimed HFCs would be counterintuitive to maximizing reclamation.

7.2 Price of Refrigerant

The costs associated with reclamation have historically been considered a barrier, with the price of refrigerants being a major factor. From interviews in 2018 and 2019, EPA learned that customers might not buy refrigerant marketed as reclaimed gas when there is virgin gas available for the same cost. However, as the phasedown of virgin HFCs progresses, prices for refrigerants containing HFCs are expected to rise as virgin HFCs become scarcer. Reclaimed refrigerants containing HFCs are also expected to rise in price, since they will be needed for similar uses as their virgin counterparts.

Based on interviews in 2018 and 2019, EPA understands that other factors may affect the price of refrigerants as well. For example, EPA heard the view that the price of R-410A may be low because of supply from overseas (*i.e.*, “dumping”). Dumping is “when a foreign producer sells a product in the United States at a price that is below that producer’s sales price in the country of origin (“home market”), or at a price that is lower than the cost of production” (U.S. EPA 2021b). Between 2016 and 2021, the U.S. Department of Commerce and the U.S. International Trade Commission have taken various actions to impose antidumping duty orders related to certain cases of imports of HFCs and blends containing HFCs. EPA also heard that market fluctuations in the price makes it difficult for reclaimers to operate profitably, and such fluctuations may be a result of various effects, including the import of refrigerants manufactured overseas into the U.S. market, court rulings, and allocation changes. As the HFC phasedown progresses, this price dynamic is expected to change, especially for high-GWP HFCs, which will likely become scarcer and/or more expensive over time. During EPA’s public workshop in 2021, EPA heard anecdotical information that the price of HFC-134a has increased by as much as 77 percent.

7.3 Market Demand for Reclaimed Refrigerant

In general, EPA understands that reclaimers process recovered refrigerant that they can profitably sell back into the market. As reclaimed refrigerants are required to meet the same purity standards as their virgin counterparts, there is no difference between virgin and reclaimed refrigerants for sale in the market. Reclaimed refrigerants are able to meet the same functionality as virgin refrigerants when used in RACHP equipment. Technicians and other consumers have historically purchased refrigerant based on the lowest cost and/or availability and have not sought out reclaimed refrigerant specifically.

It is expected that the demand for reclaimed refrigerant will increase with the progression of the HFC phasedown. Virgin refrigerants that contain HFCs will decrease; however, many existing equipment will still need these refrigerants for servicing and/or repair to reach their useful life. Reclaimed refrigerants that contain HFCs will be critical for servicing these types of existing equipment that will continue to need refrigerants that contain HFCs. Thus, the demand for reclaimed refrigerants that contain HFCs will increase and likely provide more favorable market dynamics for reclamation.

7.4 Release Events over Useful Life and Disposal of Equipment

Although there are statutory and regulatory requirements under title VI of the CAA designed to restrict certain releases of refrigerants, refrigerant release continues to pose a challenge to greater refrigerant recovery as it results in less refrigerant that can be recovered from equipment. Refrigerant release for refrigeration and air conditioning equipment can occur at several points throughout the useful life of the equipment, including installation, servicing, operation, and end-of-life disposal. The types of release may vary by equipment type, operating environments, and site-specific situations. Leak rates in refrigeration systems may vary depending on a variety of factors, including the application of the equipment and the charge size of refrigerant in the equipment. For example in commercial refrigeration equipment, leak rates may vary between 15.624.2 percent (CARB, 2020).

7.4.1 End-of-Life Leakage

Refrigeration and air conditioning equipment eventually reach the end of their useful life through either gradual or catastrophic failure of key components. The full refrigerant charge could be released if the system is physically damaged or if the system is not properly disposed of at the end of its useful life. Self-contained systems can be transported to off-site recyclers that will then recover the remaining refrigerant before disposal of the appliance. Split-system and remote condensing products as well as larger self-contained systems (*e.g.*, chillers) will generally have the refrigerant recovered on-site by technicians before equipment disposal. Regulations under CAA sections 608 and 609 require proper refrigerant recovery either on- or off-site. Feedback from industry is that refrigerant recovery at the end of life, while legally required, is not always practiced in the field, and that variance in actual practice could result in additional releases to the atmosphere at equipment end-of-life. Anecdotal feedback is that recovery is less common from residential and light commercial air conditioning equipment than from commercial refrigeration and larger air conditioning equipment.

7.5 Technician Outreach and Cost Penalty for Returning Refrigerant

Per EPA regulations under section 608 of the CAA at 40 CFR 82.156, with certain limited exceptions, before opening or disposing of an appliance technicians must ensure refrigerant is evacuated from air conditioning or refrigeration equipment to established vacuum levels. Similar requirements apply to persons opening or disposing of small appliances. These recovery requirements may cause technicians to spend time to achieve compliance. As technicians who recover refrigerant are often servicing many systems each day, the recovered refrigerant can be exposed to a range of contaminants on a daily basis. The refrigerant recovered from a given system may be contaminated or mixed with other refrigerants from previous servicing and maintenance by other technicians.

Although some technicians may use different recovery cylinders for different types of refrigerants, there is still the potential for cross-contamination from using the same cylinder to service different refrigerants or using the same hose to hook up to different cylinders. In EPA's interviews with reclaimers in 2018 and 2019, reclaimers noted that there are technology solutions on the horizon, including digital gauges and gauges built into systems, but it could take decades for these to become widely adopted. In conversations with smaller reclaiming operations, it was found that most reclaimers emphasized the importance of outreach to technicians as the fastest way to increase the amount of refrigerant reclaimed, reduce emissions, and reduce contamination (Stratus Consulting, 2010).

Technicians are often not made aware when RACHP equipment has been converted to a new refrigerant, which can lead to contamination. In interviews in 2018 and 2019, EPA learned that, if a contractor is consistently returning mixed gas for reclamation, the reclaimers test it each time and some may start charging costs for disposal, if needed. EPA understands that it may be difficult to pass these costs on to customers since one cylinder can come from multiple jobs and it is not always easy to locate the technician for additional information. If technicians return a contaminated cylinder to a wholesaler or reclaimer, they may be charged a penalty for destruction. In addition, as refrigerants transition, technicians may need to purchase new recovery machines or equipment. For example, recovery machines or equipment that are rated for A2L refrigerants that carry flammability risks may be needed.

7.6 Destruction of HFCs

Based on interviews in 2018 and 2019, EPA understands that reclaimers often contract out destruction of waste oils, contaminants, and impurities to a waste management company. When determining whether the material can be reclaimed, reclaimers may look at the laboratory data to see what the make-up of the mixed gas is, the level of contamination, and what it would take to separate it to determine whether it is worth the energy and time to reclaim. When determining what can be reclaimed, the contamination or the number of gases are important but these are not the only considerations. Some gases are much harder to separate because of their boiling points, among other factors. Mixed gases that cannot be reclaimed may be sent for destruction.

According to some reclaimers, if highly mixed refrigerants are sent for destruction, the destruction facility may charge a fee and the reclaimer may pass that fee on to the wholesaler or technician. Fees vary based on the refrigerant blend. For example, a refrigerant such as R-410A requires a small fee for disposal, while highly mixed refrigerants with unique compositions typically require a much higher fee. For example, a blend with mixed HCFC-22 could have a buy back offered for which the customer would be paid for the portion of the blend that is HCFC-22 to offset some of the disposal cost of the other contents.

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Appendix A: Subsection (h) of the AIM Act

42 U.S.C. 7675: American innovation and manufacturing

(h) Management of regulated substances

(1) In general

For purposes of maximizing reclaiming and minimizing the release of a regulated substance from equipment and ensuring the safety of technicians and consumers, the Administrator shall promulgate regulations to control, where appropriate, any practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment (including requiring, where appropriate, that any such servicing, repair, disposal, or installation be performed by a trained technician meeting minimum standards, as determined by the Administrator) that involves-

(A) a regulated substance;

(B) a substitute for a regulated substance;

(C) the reclaiming of a regulated substance used as a refrigerant; or

(D) the reclaiming of a substitute for a regulated substance used as a refrigerant.

(2) Reclaiming

(A) In general

In carrying out this section, the Administrator shall consider the use of authority available to the Administrator under this section to increase opportunities for the reclaiming of regulated substances used as refrigerants.

(B) Recovery

A regulated substance used as a refrigerant that is recovered shall be reclaimed before the regulated substance is sold or transferred to a new owner, except where the recovered regulated substance is sold or transferred to a new owner solely for the purposes of being reclaimed or destroyed.

(3) Coordination

In promulgating regulations to carry out this subsection, the Administrator may coordinate those regulations with any other regulations promulgated by the Administrator that involve-

(A) the same or a similar practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment; or

(B) reclaiming.

(4) Inapplicability

No regulation promulgated pursuant to this subsection shall apply to a regulated substance or a substitute for a regulated substance that is contained in a foam.

(5) Small business grants

(A) Definition of small business concern

In this paragraph, the term "small business concern" has the same meaning as in section 632 of title 15.

(B) Establishment

Subject to the availability of appropriations, the Administrator shall establish a grant program to award grants to small business concerns for the purchase of new specialized equipment for the recycling, recovery, or reclamation of a substitute for a regulated substance, including the purchase of approved refrigerant recycling equipment (as defined in section 609(b) of the Clean Air Act (42 U.S.C. 7671h(b))) for recycling, recovery, or reclamation in the service or repair of motor vehicle air conditioning systems.

(C) Matching funds

The non-Federal share of a project carried out with a grant under this paragraph shall be not less than 25 percent.

(D) Authorization of appropriations

There is authorized to be appropriated to carry out this paragraph $5,000,000 for each of fiscal years 2

MEMORANDUM

DATE: XXX, 2024

TO: EPA-HQ-OAR-2022-0606

FROM: Chenise Farquharson

SUBJECT: **Confidentiality Determinations and Emission Data Designations for Data Elements in the final rule entitled "Phasedown of Hydrofluorocarbons: Management of Certain Hydrofluorocarbons and Substitutes under Subsection (h) of the American Innovation and Manufacturing Act of 2020"**

This memo documents the Agency's determination of whether to provide or not provide confidential treatment to individual reported data elements that would be submitted to the Agency or a third-party under its final rule under subsection (h) of the American Innovation and Manufacturing (AIM) Act entitled "Phasedown of Hydrofluorocarbons: Management of Certain Hydrofluorocarbons and Substitutes under Subsection (h) of the American Innovation and Manufacturing Act of 2020." This document outlines EPA's determination as to whether an individual data element will be handled as confidential or not confidential. It also notes where the Agency determines that certain categories of information are "emission data" under 40 CFR 2.301(a). The determinations that are being finalized with this rulemaking parallel the proposed determinations for the corresponding data elements, with minor edits for clarity and to correct typographical errors, as well as to clarify the rationale for the final determinations. *See* 88 FR 72216, 72279-72282 (describing proposed determinations for data elements reported to EPA under the leak repair provisions) and *id.* at 72285-72286 (describing proposed determinations for data elements related to fire suppression). Section V of the *Federal Register* notice for the final rule summarizes these determinations. There may be reasons other than business confidentiality protections not to release individual data elements determined to be not entitled to confidential treatment through this rulemaking. For example, the information could reveal personally identifiable information (PII) in certain circumstances, which may be protected disclosure. The Agency will make separate determinations in these instances.

TABLE 1: Determination of confidentiality status for data elements related to reports on chronically leaking appliances[1]

Description of data element	Confidentiality Status & Rationale	Rationale
Identification Information (owner name, facility name, facility address where appliance is located)	No confidential treatment/Emissions Data	These reports are required for appliances that have leaked 125% or more of their full charge in a calendar year, and thus are inherently reports on emissions of regulated substances. Basic identification information is necessary to interpret these reports and determine the identity of the emissions by the source. Accordingly, EPA considers this "[i]nformation necessary to determine the identity, amount, frequency, concentration . . . of any emission which has been emitted by the source . . ." and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(A). Alternatively, EPA considers this information part of a "general description of the location and/or nature of the source to the extent necessary to identify the source and to distinguish it from other sources (including, to the extent necessary for such purposes, a description of the device, installation, or operation constituting the source)" under 40 CFR 2.301(a)(2)(i)(C). Additionally, this information is not customarily closely held or kept private by companies and is generally readily ascertainable by third parties.
Appliance ID or Description (for facilities with multiple appliances)	No confidential treatment/Emissions Data	These reports are required for appliances that have leaked 125% or more of their full charge in a calendar year, and thus are inherently reports on emissions of regulated substances. For facilities with multiple appliances, the identity of the specific appliance responsible

[1] These reports on chronically leaking appliances would be required under the requirement at 40 CFR 84.106(j). References to "appliances" in Tables 1 & 2 refer to refrigerant-containing appliances as the term is defined in the regulation.

		for the leaks/emissions is necessary to interpret these reports. Accordingly, EPA considers this "[i]nformation necessary to determine the identity, amount, frequency, concentration . . . of any emission which has been emitted by the source . . ." and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(A). Alternatively, this information could be characterized as "[i]nformation necessary to determine the identity, amount, frequency, concentration, or other characteristics (to the extent related to air quality) of the emissions which, under an applicable standard or limitation, the source was authorized to emit," and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(B), because the regulations countenance some leaks provided that the applicable leak rate is not exceeded or the required leak repair activities are observed. Additionally, EPA considers this information part of a "general description of the location and/or nature of the source to the extent necessary to identify the source and to distinguish it from other sources (including, to the extent necessary for such purposes, a description of the device, installation, or operation constituting the source)" under 40 CFR 2.301(a)(2)(i)(C). Additionally, this information is not customarily closely held or kept private by companies, as the information can typically be viewed or ascertained by someone examining the appliance.
Appliance type (comfort cooling, IPR, or commercial refrigeration)	No confidential treatment/Emissions Data	These reports are required for appliances that have leaked 125% or more of their full charge in a calendar year, and thus are inherently reports on emissions of regulated substances. Information on appliance type is necessary to understand which leak rate is applicable to the appliance and helps EPA to understand the nature and sufficiency of the repair effort. Accordingly, EPA considers this "[i]nformation necessary to determine the identity, amount, frequency, concentration. . . of any emission which has been emitted by the source . . ." and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(A). Alternatively, this information could be characterized as "[i]nformation necessary to determine the identity, amount, frequency,

		concentration, or other characteristics (to the extent related to air quality) of the emissions which, under an applicable standard or limitation, the source was authorized to emit," and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(B), because the regulations countenance some leaks provided that the applicable leak rate is not exceeded or the required leak repair activities are observed. Additionally, EPA considers this information part of a "general description of the location and/or nature of the source to the extent necessary to identify the source and to distinguish it from other sources (including, to the extent necessary for such purposes, a description of the device, installation, or operation constituting the source)" under 40 CFR 2.301(a)(2)(i)(C). Additionally, this information is not customarily closely held or kept private by companies and is generally readily ascertainable by third parties based on what they can observe the facility does.
Refrigerant type	No confidential treatment/Emissions Data	These reports are required for appliances that have leaked 125% or more of their full charge in a calendar year, and thus are inherently reports on emissions of regulated substances. Information on refrigerant type is necessary to interpret these reports because it allows EPA to understand the identity of the emissions, the GWP of the refrigerant, and in some cases the applicability of other regulatory controls. Accordingly, EPA considers this "[i]nformation necessary to determine the identity, amount, frequency, concentration . . . of any emission which has been emitted by the source . . ." and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(A). Alternatively, this information could be characterized as "[i]nformation necessary to determine the identity, amount, frequency, concentration, or other characteristics (to the extent related to air quality) of the emissions which, under an applicable standard or limitation, the source was authorized to emit," and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(B) because the regulations countenance some leaks provided that the applicable leak rate is not exceeded or the

		required leak repair activities are observed. Additionally, EPA considers this information part of a "general description of the location and/or nature of the source to the extent necessary to identify the source and to distinguish it from other sources (including, to the extent necessary for such purposes, a description of the device, installation, or operation constituting the source)" under 40 CFR 2.301(a)(2)(i)(C). Additionally, this information is not customarily closely held or kept private by companies and is generally readily ascertainable by third parties.
Full charge of appliance (pounds)	No confidential treatment/Emissions Data	These reports are required for appliances that have leaked 125% or more of their full charge in a calendar year, and thus are inherently reports on emissions of regulated substances. Information on the full charge is necessary to interpret these reports because it allows EPA to understand the potential amount of emissions from the appliance, and in some cases the applicability of other regulatory controls (e.g., automatic leak detection). Accordingly, EPA considers this "[i]nformation necessary to determine the identity, amount, frequency, concentration . . . of any emission which has been emitted by the source . . ." and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(A). Alternatively, this information could be characterized as "[i]nformation necessary to determine the identity, amount, frequency, concentration, or other characteristics (to the extent related to air quality) of the emissions which, under an applicable standard or limitation, the source was authorized to emit," and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(B), because the regulations countenance some leaks provided that the applicable leak rate is not exceeded or the required leak repair activities are observed. Additionally, EPA considers this a "general description of the location and/or nature of the source to the extent necessary to identify the source and to distinguish it from other sources (including, to the extent necessary for such purposes, a description of the device, installation, or operation constituting the

		source)" under 40 CFR 2.301(a)(2)(i)(C). Additionally, this information is not customarily closely held or kept private by companies and generally anyone can roughly estimate the full charge of an appliance based on appliance category.
Annual percent refrigerant loss	No confidential treatment/Emissions Data	These reports are required for appliances that have leaked 125% or more of their full charge in a calendar year, and thus are inherently reports on emissions of regulated substances. Information on the percent refrigerant loss is necessary to interpret these reports because it allows EPA to understand the amount of refrigerant emitted relative to the full charge of the appliance. Accordingly, EPA considers this "[i]nformation necessary to determine the identity, amount, frequency, concentration . . . of any emission which has been emitted by the source . . ." and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(A). Alternatively, this information could be characterized as "[i]nformation necessary to determine the identity, amount, frequency, concentration, or other characteristics (to the extent related to air quality) of the emissions which, under an applicable standard or limitation, the source was authorized to emit," and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(B), because the regulations countenance some leaks provided that the applicable leak rate is not exceeded or the required leak repair activities are observed. Additionally, this percentage loss information is not customarily closely held or kept private by companies.
Dates of refrigerant addition	No confidential treatment/Emissions Data	These reports are required for appliances that have leaked 125% or more of their full charge in a calendar year, and thus are inherently reports on emissions of regulated substances. Information on the amount of refrigerant added and the dates the addition took place allows EPA to determine whether the owner/operator was regulatorily required to repair the appliance and the deadline for such repair. This

		also allows EPA to understand the amount of refrigerant emitted relative to the full charge of the appliance. Accordingly, EPA considers this "[i]nformation necessary to determine the identity, amount, frequency, concentration . . . of any emission which has been emitted by the source . . ." and therefore "emission data" under 40 CFR 2.301(a)(2)(A)(i). Alternatively, this information could be characterized as "[i]nformation necessary to determine the identity, amount, frequency, concentration, or other characteristics (to the extent related to air quality) of the emissions which, under an applicable standard or limitation, the source was authorized to emit," and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(B), because the regulations countenance some leaks provided that the applicable leak rate is not exceeded or the required leak repair activities are observed. Additionally, dates of this nature are not information that is customarily closely held or kept private by companies.
Amounts of refrigerant added	No confidential treatment/Emissions Data	These reports are required for appliances that have leaked 125% or more of their full charge in a calendar year, and thus are inherently reports on emissions of regulated substances. Information on the amount of refrigerant added and the dates the addition took place allows EPA to determine whether the owner/operator was regulatorily required to repair the appliance and the deadline for such repair. This also allows EPA to understand the amount of refrigerant emitted relative to the full charge of the appliance. Accordingly, EPA considers this "[i]nformation necessary to determine the identity, amount, frequency, concentration . . . of any emission which has been emitted by the source . . ." and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(A). Alternatively, this information could be characterized as "[i]nformation necessary to determine the identity, amount, frequency, concentration, or other characteristics (to the extent related to air quality) of the emissions which, under an applicable standard or limitation, the source was authorized to emit,"

		and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(B), because the regulations countenance some leaks provided the applicable leak rate is not exceeded or the required leak repair activities are observed. Additionally, this information is not customarily closely held or kept private by companies, as EPA anticipates that it is not considered commercially valuable information.
Date of last successful follow-up verification test	No confidential treatment/Emissions Data	These reports are required for appliances that have leaked 125% or more of their full charge in a calendar year, and thus are inherently reports on emissions of regulated substances. Information on the date of the last successful follow-up verification test allows EPA to confirm compliance with regulatorily required repair and verification requirements, which are designed to reduce the overall emissions of the appliance below the applicable leak rate threshold. Accordingly, EPA considers this "[i]nformation necessary to determine the identity, amount, frequency, concentration . . . of any emission which has been emitted by the source . . ." and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(A). Alternatively, this information could be characterized as "[i]nformation necessary to determine the identity, amount, frequency, concentration, or other characteristics (to the extent related to air quality) of the emissions which, under an applicable standard or limitation, the source was authorized to emit," and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(B), because the regulations countenance some leaks provided that the required leak repair activities, including a successful follow-up verification test, are observed. Additionally, dates of this nature are not information customarily closely held or kept private by companies.
Explanation of cause of refrigerant losses (Narrative)	No confidential treatment/Emissions	These reports are required for appliances that have leaked 125% or more of their full charge in a calendar year, and thus are inherently

	Data	reports on emissions of regulated substances. An explanation of the cause of the refrigerant loss allows EPA to understand the nature, amount, and/or frequency of the emissions and if better controls or practices may have avoided them. Accordingly, EPA considers this "[i]nformation necessary to determine the identity, amount, frequency, concentration . . . of any emission which has been emitted by the source . . ." and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(A). Alternatively, this information could be characterized as "[i]nformation necessary to determine the identity, amount, frequency, concentration, or other characteristics (to the extent related to air quality) of the emissions which, under an applicable standard or limitation, the source was authorized to emit," and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(B), because the regulations countenance some leaks provided that the required leak repair activities are observed and because this information also helps EPA to confirm that required leak inspections took place. Additionally, this information is not customarily closely held or kept private by companies. This information does not provide insight into facility processes or operation. Causes of refrigerant leaks can be broadly categorized (e.g., failure of a particular component, employee error, etc.). Common causes of leaks are well understood by technicians and narrative responses would not contain information regarding the customization of an appliance to the extent the owner considers that customization proprietary.
Description of the repair actions taken (Narrative)	No confidential treatment/Emissions Data	These reports are required for appliances that have leaked 125% or more of their full charge in a calendar year, and thus are inherently reports on emissions of regulated substances. An explanation of the repair actions taken allows EPA to confirm regulatory compliance and the nature, amount and/or frequency of the emissions that predicated the repair. Accordingly, EPA considers this "[i]nformation necessary to determine the identity, amount, frequency, concentration . . . of any

		emission which has been emitted by the source . . .” and therefore “emission data” under 40 CFR 2.301(a)(2)(i)(A). Alternatively, this information could be characterized as “[i]nformation necessary to determine the identity, amount, frequency, concentration, or other characteristics (to the extent related to air quality) of the emissions which, under an applicable standard or limitation, the source was authorized to emit,” and therefore “emission data” under 40 CFR 2.301(a)(2)(i)(B), because the regulations countenance some leaks provided that the required leak repair activities are observed and because this information would help EPA to confirm that required repair activities took place. Additionally, this information is not customarily closely held or kept private by companies. This information does not provide insight into facility processes or operation. Repair methods can be categorized broadly (e.g., replacement of a specific component part and leak testing, etc.). Common repair methods are well understood by technicians and narrative responses would not contain information regarding the customization of an appliance to the extent the owner considers that customization proprietary.
Whether a retrofit or retirement plan been developed for the appliance, and, if so, the anticipated date of retrofit or retirement	No confidential treatment/Emissions Data	These reports are required for appliances that have leaked 125% or more of their full charge in a calendar year, and thus are inherently reports on emissions of regulated substances. These reports would include information related to the identity of the refrigerant and the schedule for the retrofit or retirement, if applicable (retrofits would include repairs of leaks). Thus, information in this report allows EPA to understand emissions from the appliance that have occurred and would be likely to occur before the plan was completed. Accordingly, EPA considers this “[i]nformation necessary to determine the identity, amount, frequency, concentration . . . of any emission which has been emitted by the source . . .” and therefore “emission data” under 40 CFR 2.301(a)(2)(i)(A). Alternatively, this information could be characterized as “[i]nformation necessary to determine the identity,

		amount, frequency, concentration, or other characteristics (to the extent related to air quality) of the emissions which, under an applicable standard or limitation, the source was authorized to emit," and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(B), because the regulations countenance some leaks provided that the required leak repair activities are observed and in some circumstances the required leak repair activities would include preparation of a retrofit or retirement plan. Additionally, this information is not customarily closely held or kept private by companies. This information is a yes/no and a date, and this does not reveal anything about facility processes, operation, or—in the case of industrial process refrigeration—production volume. Additionally, if a retrofit or retirement is scheduled, that fact is likely readily ascertainable by third parties because the regulated entity would necessarily be purchasing a replacement and engaging a technician to perform the retrofit or replacement.

TABLE 2: Determination of confidentiality status for data elements related to other leak repair notifications and extension requests

Description of data element	Confidentiality status	Rationale
Extension of time to complete repairs: Identification and address of the facility; the name of the owner or operator of the appliance; the leak rate; the method used to determine the leak rate and full charge; the date the appliance exceeded the applicable leak rate; the location of leak(s) to the extent determined to date; any repair	No confidential treatment/Emissions Data	Under a limited set of circumstances, the regulations provide for extensions to the time frame for regulatorily required repairs to occur. During this time, the regulations do not prohibit an owner/operator for operating an appliance while it is leaking, and they do not prohibit adding additional refrigerant to that appliance. Thus, the information in these extension requests allows EPA to determine the identity of a leaking appliance as well as the rate of the leak and location of the leak(s). Accordingly, EPA considers this

work that has been performed thus far, including the date that work was completed; the reasons why more than 30 days (or 120 days if an industrial process shutdown is required) are needed to complete the repair; and an estimate of when the work will be completed. If the estimated completion date is to be extended, a new estimated date of completion and documentation of the reason for that change must be submitted to EPA within 30 days of identifying that the completion date must be extended.		"[i]nformation necessary to determine the identity, amount, frequency, concentration . . . of any emission which has been emitted by the source . . ." and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(A). Alternatively, this information could be characterized as "[i]nformation necessary to determine the identity, amount, frequency, concentration, or other characteristics (to the extent related to air quality) of the emissions which, under an applicable standard or limitation, the source was authorized to emit," and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(B) because the regulations countenance some leaks provided that the required leak repair activities are observed. Additionally, this timeframe information is not customarily closely held or kept private by companies.
Relief from the obligation to retrofit or retire an appliance: The date that the requirement to develop a retrofit or retirement plan was triggered; the leak rate; the method used to determine the leak rate and full charge; the location of the leak(s) identified in the leak inspection; a description of repair work that has been completed; a description of repair work that has not been completed; a description of why the repair was not conducted within the applicable time frame; and a statement signed by an authorized company official that all identified leaks will be repaired and an estimate of when those repairs will be completed (not	No confidential treatment/Emissions Data	The regulations would require the retrofit or retirement of an appliance that has been leaking over the applicable leak rate threshold if that appliance is not repaired within the required time window. If the appliance is subsequently repaired such that it is no longer leaking at or above the applicable leak rate threshold, the owner/operator can submit a request to be relieved from the obligation to retrofit or retire the appliance. The information in these requests allows EPA to confirm the appliance has been repaired such that it is no longer leaking above the leak rate threshold before relieving the owner/operator of the obligation to retrofit or retire that appliance. Accordingly, EPA considers this "[i]nformation necessary to determine the identity, amount, frequency, concentration . . . of any emission which has been emitted by the source . . ." and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(A). Alternatively, this information could be characterized as "[i]nformation necessary to determine the identity, amount, frequency, concentration, or

to exceed one year from date of the plan).		other characteristics (to the extent related to air quality) of the emissions which, under an applicable standard or limitation, the source was authorized to emit," and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(B) because the regulations countenance some leaks provided that the required leak repair activities are observed. Additionally, this timeframe information is not customarily closely held or kept private by companies.
Extension of time to complete the retrofit or retirement of an appliance: Identification of the appliance; name of the owner or operator; the leak rate; the method used to determine the leak rate and full charge; the date the appliance exceeded the applicable leak rate; the location of leak(s) to the extent determined to date; any repair work that has been finished thus far, including the date that work was finished; a plan to finish the retrofit or retirement of the appliance; the reasons why more than one year is necessary to retrofit or retire the appliance; the date of notification to EPA; and an estimate of when retrofit or retirement work will be finished.	No confidential treatment/Emissions Data	The regulations would require the retrofit or retirement of an appliance that has been leaking over the applicable leak rate threshold if that appliance is not repaired within the required time window. Under certain circumstances, owner/operators may request an extension of the time allotted to complete a retrofit or retirement. During that time, the owner/operator can continue to operate an appliance even though it may be leaking above the leak rate threshold. The information contained in these extension requests allows EPA to understand the level of emissions (leaks) and the circumstances that warrant an extended retrofit or retirement scheduled. Accordingly, EPA considers this "[i]nformation necessary to determine the identity, amount, frequency, concentration . . . of any emission which has been emitted by the source . . ." and therefore "emission data" under 40 CFR 2.301(a)(2)(A)(i). Alternatively, this information could be characterized as "[i]nformation necessary to determine the identity, amount, frequency, concentration, or other characteristics (to the extent related to air quality) of the emissions which, under an applicable standard or limitation, the source was authorized to emit," and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(B) because the regulations countenance some leaks provided that the required

		leak repair activities are observed. Additionally, this timeframe information is not customarily closely held or kept private by companies.
Notification of exclusion of purged refrigerants that are destroyed from annual leak rate calculations: The identification of the facility and a contact person, including the address and telephone number; a description of the appliance, focusing on aspects relevant to the purging of refrigerant and subsequent destruction; a description of the methods used to determine the quantity of refrigerant sent for destruction and type of records that are being kept by the owners or operators where the appliance is located; the frequency of monitoring and data-recording; and a description of the control device, and its destruction efficiency.	No confidential treatment/Emissions Data	The regulation provides that in calculating annual leak rates, purged refrigerant that is destroyed at a verifiable destruction efficiency would not be counted toward the leak rate. The information in these notifications is used to confirm that refrigerant that is excluded as "purged refrigerant" has been destroyed rather than emitted. Accordingly, EPA considers this "[i]nformation necessary to determine the identity, amount, frequency, concentration . . . of any emission which has been emitted by the source . . ." and therefore "emission data" under 40 CFR 2.301(a)(2)(A)(i). Alternatively, this information could be characterized as "[i]nformation necessary to determine the identity, amount, frequency, concentration, or other characteristics (to the extent related to air quality) of the emissions which, under an applicable standard or limitation, the source was authorized to emit," and therefore "emission data" under 40 CFR 2.301(a)(2)(i)(B) because the regulations countenance some leaks provided that the required leak repair activities are observed. Additionally, this notice information is not customarily closely held or kept private by companies.

TABLE 3: Determination of confidentiality status for data elements related to reports on fire suppression

Description of data element	**Confidentiality Status**	**Rationale**
Identification Information (owner name, facility name, facility address where equipment is located)	No confidential treatment	EPA does not anticipate that this information would provide insight into facility processes or operation. EPA also does not anticipate that facilities keep this information private or secure. Accordingly, this information is not customarily closely held or kept private by companies.
Quantity of material (the combined mass of regulated substance and contaminants) by regulated substance broken out by sold, recovered, recycled, and virgin for the purpose of installation of new equipment and servicing of fire suppression equipment	No confidential treatment	EPA does not anticipate that this inventory information would provide insight into facility processes or operation. EPA also does not anticipate that facilities keep this information private or secure. Accordingly, this information is not customarily closely held or kept private by companies.

Total mass of each regulated substance broken out by sold, recovered, recycled, and virgin	No confidential treatment	EPA does not anticipate that this inventory information would provide insight into facility processes or operation. EPA also does not anticipate that facilities keep this information private or secure. Accordingly, this information is not customarily closely held or kept private by companies.
Total mass of waste products sent for disposal, along with information about the disposal facility if waste is not processed by the reporting entity	No confidential treatment	EPA does not anticipate that this inventory information would provide insight into facility processes or operation. EPA also does not anticipate that facilities keep this information private or secure. Accordingly, this information is not customarily closely held or kept private by companies.

Recordkeeping and Reporting of the Management of Certain Hydrofluorocarbons and Substitutes under Subsection (h) of the American Innovation and Manufacturing Act of 2020

PART A OF THE SUPPORTING STATEMENT

Title: Recordkeeping and Reporting of the Management of Certain Hydrofluorocarbons and Substitutes under Subsection (h) of the American Innovation and Manufacturing Act of 2020

OMB Number: 2060-NEW; EPA ICR Number: 2778.02

Short Characterization

The American Innovation and Manufacturing (AIM) Act of 2020 authorizes EPA to address hydrofluorocarbons (HFCs)[1] in three main ways: phasing down HFC production and consumption through an allowance allocation program; promulgating certain regulations for HFCs and their substitutes for purposes of maximizing reclamation and minimizing releases of HFCs from equipment and ensuring the safety of technicians and consumers; and facilitating the transition to next-generation technologies by restricting use of these HFCs in the sector or subsectors in which they are used.

This ICR covers provisions under subsection (h) of the AIM Act that establishes a program for the management of HFCs, including requirements for leak repair and use of automatic leak detection (ALD) systems for certain refrigerant-containing appliances containing HFCs and certain substitutes; use of reclaimed HFCs for the servicing and/or repair of refrigerant-containing equipment in certain refrigeration, air conditioning, and heat pumps (RACHP) subsectors; the servicing, repair, disposal, or installation of fire suppression equipment that contains HFCs, including the use of recycled HFCs for the initial installation and the servicing and/or repair of fire suppression equipment, as well as requirements related to technician training in the fire suppression sector; and removal of HFCs from disposable cylinders. In accordance with the subsection (h) final rulemaking "Phasedown of Hydrofluorocarbons: Management of Certain Hydrofluorocarbons and Substitutes under Subsection (h) of the American Innovation and Manufacturing Act of 2020, owners/operators, technicians, reclaimers, and recyclers are required to electronically report data to EPA. Additionally, the rulemaking finalizes alternative Resource Conservation and Recovery Act (RCRA) standards for certain spent ignitable refrigerants being recycled for reuse.

For the three years covered by this ICR, the total respondent burden associated with this information collection will average 222,268 hours per year and the respondent cost will average $17,069,893 per year. This includes an average of $3,647,230 per year for reporting, $9,018,098 per year for recordkeeping, and $2,131,844 avoided per year for reclamation reporting and recordkeeping. Over the same time period, the total estimated cost for EPA of the information collection will average $332,296 per year. The total estimated cost for all respondents and EPA will average $17,402,188 per year. These totals reflect the avoided burden and costs for reclaimers associated with the requirements for use of reclaimed HFCs.

[1] The AIM Act refers to the HFCs that are regulated under its provisions as regulated substances. EPA uses the terms "regulated substance" and "HFC" interchangeably in this document.

Actions to Comply with Terms of Clearance

This is a new ICR and, in accordance with 5 CFR 1320, the information collection will be approved for three years. As terms of clearance, however, the agency is required to closely track the frequency with which this collection is used and (1) submit a request for revision if the actual burden exceeds the expected level approved in this ICR; and (2) ensure that the burden reflected in the renewal is accurate.

1. Necessity for the Information Collection

This information collection is authorized under the AIM Act (Section 103 in Division S, Innovation for the Environment, of the Consolidated Appropriations Act, 2021 (Pub. L. 116-260), codified at 42 U.S.C. § 7675). In subsection (k)(1)(A), the AIM Act provides EPA with the authority to promulgate such regulations as are necessary to carry out EPA's functions under the Act. Also, Subsection (k)(1)(C) of the AIM Act states that section 114 of the CAA applies to the AIM Act and rules promulgated under it as if the AIM Act were included in title VI of the CAA. Thus, section 114 of the Clean Air Act, which provides authority to EPA Administrator to require recordkeeping and reporting in carrying out provisions of the CAA, also applies to and supports this rulemaking.

Consistent with the AIM Act's provision in subsection (h) that "for the purposes of maximizing reclaiming and minimizing the release of a regulated substance from equipment and ensuring the safety of technicians and consumers, the Administrator shall promulgate regulations to control, where appropriate, any practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment." The provisions in the final rule apply to equipment owners/operators, technicians, reclaimers, fire suppressant recyclers, final processors, wholesalers, and/or distributors, as applicable. The provisions apply to those entities, as applicable, that are performing leak repair of appliances containing at least 15 pounds of a refrigerant containing HFC(s) or a substitute for an HFC with a global warming potential (GWP) greater than 53, with specific exceptions; installing and using automatic leak detection systems for certain refrigerant-containing appliances containing 1,500 pounds or more of a refrigerant that contains an HFC or a substitute for an HFC with a GWP greater than 53 for both new and certain existing appliances; using reclaimed HFCs in certain RACHP subsectors for the servicing and/or repair of refrigerant-containing equipment starting January 1, 2029; labeling of containers of reclaimed HFC refrigerants to certify the limit on virgin HFCs for reclaimed HFC refrigerants is not exceeded; and adhering to requirements regarding the servicing, repair, disposal, or installation of fire suppression equipment that contains HFCs, with the purpose of minimizing the release of HFCs from that equipment, as well as requirements related to technician training in the fire suppression sector. Such entities are required to submit to the Administrator reports, maintain records, and implement labeling requirements on cylinders that contain reclaimed HFCs, as applicable.

EPA is requiring reporting and recordkeeping to facilitate compliance with and enforcement of the requirements under subsection (h). The labels for cylinders will indicate the substance being sold, information regarding when and by whom the material was reclaimed, and a unique serial number associated with the container.

The Paperwork Reduction Act (PRA) requires Federal agencies to manage information resources to reduce information collection burdens on the public; increase program efficiency and effectiveness; and improve the integrity, quality, and utility of information to all users within and outside the Agency, including capabilities for ensuring dissemination of public information, public access to government information, and protections for privacy and security (44 USC 3506).

2. Practical Utility/Users of the Data

The reporting, recordkeeping, and labeling requirements under subsection (h) enable EPA to ensure compliance with the requirements for:

- leak repair of refrigerant-containing appliances with 15 pounds or more of a refrigerant that contains HFC(s) or a substitute for an HFC with a GWP greater than 53. The leak repair requirements exempt refrigerant-containing equipment in the residential and light commercial air conditioning and heat pumps subsector;
- installation and use of automatic leak detection systems for commercial refrigeration or industrial process refrigeration appliances containing 1,500 pounds or more of a refrigerant that contains an HFC or a substitute for an HFC with a GWP greater than 53 for both new and certain existing appliances;
- a reclamation standard limiting the amount of virgin HFCs that can be contained in reclaimed HFC refrigerants;
- use of reclaimed HFCs in certain sectors or subsectors for the servicing and/or repair of refrigerant-containing equipment in certain RACHP subsectors starting January 1, 2029;
- use of recycled HFCs for initial installation and servicing and/or repair of fire suppression equipment starting January 1, 2030, and January 1, 2026, respectively;
- the servicing, repair, disposal, or installation of fire suppression equipment that contains HFCs, with the purpose of minimizing the release of HFCs from that equipment, as well as requirements related to technician training in the fire suppression sector;
- labeling cylinders of reclaimed HFCs to certify the contents meet the limit on virgin HFCs; and
- the alternate compliance method for evacuation of the heel of a disposable cylinder to a specified level of vacuum before discarding the cylinder.

3. Consideration Given to Information Technology

EPA will leverage existing electronic reporting and data tracking systems used in prior AIM Act rules and the Greenhouse Gas Reporting Program (GHGRP)[2] to collect, track, and store information required under this ICR. The systems are designed to collect and store CBI in compliance with U.S. government security standards.

4. Non-duplication

EPA intends to collect many reports required by this ICR electronically through existing web-based systems used to collect data under the GHGRP and prior AIM Act rulemakings, which will help minimize duplicative reporting.

Under the Allocation Framework Rule, EPA requires quarterly activity and annual inventory reporting by fire suppressant recyclers. Under this ICR, entities that perform first fill of equipment, service (e.g., recharge) equipment, and/or recycle HFCs in the fire suppression sector are required to report on activity annually and are not required to report on annual inventory. EPA collected

[2] The GHGRP requires reporting of greenhouse gas (GHG) data and other relevant information from large GHG emission sources, fuel and industrial gas suppliers, and carbon dioxide (CO_2) injection sites in the United States. The program generally requires reporting when emissions from covered sources are greater than 25,000 metric tons of CO_2e per year. Publicly available information includes facility names, addresses, and latitude/longitude information.

comments on the proposed reporting requirements and whether compliance with one set of requirements would satisfy both obligations. EPA intends to limit to the extent practicable duplicative burden between part 84 subparts A and C by using the same reporting systems. If there are any duplicative requirements, entities would only report once.

5. Effects on Small Entities

The burden on small entities has been reduced to every extent possible including collecting reports from entities as far "upstream" as possible (e.g., equipment owner or operator) and using existing reporting infrastructure and data elements from prior AIM Act rules and Section 608 of the Clean Air Act.

6. Consequences of Not Conducting Collection

Fire suppressant recycling reports are required on an annual basis, and chronic leak reports are submitted once a year (as applicable). Reporting on sale and distribution of reclaimed HFC refrigerants intended for the servicing and/or repair of refrigerant-containing equipment in certain RACHP subsectors is a two-time reporting requirement – once on February 14, 2027, and once on February 14, 2028. The remaining information collection requirements are occasional submissions. Occasional submissions, such as requests for extensions to repair, retrofit, or retirement timelines, are designed to allow entities flexibility in meeting regulatory requirements.

7. Special Circumstances

This collection of information has a three-year requirement for record and report retention, which is consistent with the three-year requirement for record retention specified in the general information collection guidelines in 5 CFR 1320.5(f) of the OMB regulations implementing the Paperwork Reduction Act and with all other OMB guidelines at 5 CFR 1320.5(d)(2).

8. Consultations with Persons Outside the Agency

(a) Public Notice Required Prior to ICR submission to OMB

The proposed rulemaking "Phasedown of Hydrofluorocarbons: Management of Certain Hydrofluorocarbons and Substitutes under Subsection (h) of the American Innovation and Manufacturing Act of 2020" served as the public notice for this ICR. EPA requested comment on this ICR in that proposed rulemaking.

(b) Consultations

The burden calculations were developed based on EPA's experience implementing reporting and recordkeeping requirements on ozone-depleting substances (ODS) and HFCs.

EPA also collected comments on the proposed rulemaking "Phasedown of Hydrofluorocarbons: Management of Certain Hydrofluorocarbons and Substitutes under Subsection (h) of the American Innovation and Manufacturing Act of 2020" and adjusted this ICR based on the comments received.

9. Payments or Gifts to Respondents

No payments or gifts will be made to respondents.

10. Confidentiality

For all data elements that EPA has determined to be confidential or for which EPA will provide provisional confidential treatment if claimed by reporters as CBI, EPA will release aggregated data if there are three or more reporting entities.

11. Sensitive Questions

This section is not applicable because this ICR does not involve matters of a sensitive nature.

12. Estimating Burden and Cost of Collection

(a) Information Requested

i) Data items

All persons that own, operate, or service/repair refrigerant-containing appliances with a charge size of 15 pounds or more of a refrigerant containing an HFC or a substitute for an HFC with a GWP greater than 53; owners or operators of commercial refrigeration or industrial process refrigeration appliances that contain 1,500 pounds or more of a refrigerant that contains an HFC or a substitute for an HFC with a GWP greater than 53 who are required to use an ALD system; all persons that perform first fill of equipment, service (e.g., recharge) equipment, and/or recycle HFCs in the fire suppression sector; reclaimers of HFC refrigerants; those who sell or distribute or offer for sale or distribution reclaimed HFCs; technicians who evacuate disposable cylinders to a specified level of vacuum prior to discarding the cylinder; or final processors who accept evacuated disposable cylinders must record and/or report the following information either on an annual or as-needed basis.

Owners and Operators of HFC Refrigerant-Containing Appliances

Request for Leak Repair Extension Requirements:

- Identification and address of the facility;
- The name of the owner or operator of the refrigerant-containing appliance;
- The leak rate;
- The method used to determine the leak rate and full charge;
- The date the refrigerant-containing appliance exceeded the applicable leak rate;
- The location of leak(s) to the extent determined to date;
- Any repair work that has been performed thus far, including the date that work was completed;
- The reasons why more than 30 days (or 120 days if an industrial process shutdown is required) are needed to complete the repair;
- An estimate of when the work will be completed; and
- If the estimated completion date is to be extended, a new estimated date of completion and documentation of the reason for that change.

Request to Cease Retrofit/Retirement Plan Requirements:

- The date that the requirement to develop a retrofit or retirement plan was triggered;
- The leak rate;

- The method used to determine the leak rate and full charge;
- The location of the leak(s) identified in the leak inspection;
- A description of repair work that has been completed;
- A description of repair work that has not been completed;
- A description of why the repair was not conducted within the time frames required; and
- A statement signed by an authorized company official that all identified leaks will be repaired and an estimate of when those repairs will be completed (not to exceed one year from date of the plan).

Request for Retrofit/Retirement Plan Extension Requirements (for industrial process refrigeration equipment only):

- The identification of the refrigerant-containing appliance;
- The name of the owner or operator;
- The leak rate;
- The method used to determine the leak rate and full charge;
- The date the refrigerant-containing appliance exceeded the applicable leak rate;
- The location of leak(s) to the extent determined to date;
- Any repair work that has been finished thus far, including the date that work was finished;
- A plan to finish the retrofit or retirement of the refrigerant-containing appliance;
- The reasons why more than one year is necessary to retrofit or retire the refrigerant-containing appliance;
- The date of notification to EPA;
- An estimate of when retrofit or retirement work will be finished; and
- If the estimated completion date is to be revised, a new estimated date of completion and documentation of the reason for that change.

Chronic Leak Reporting Requirements:

- Appliance owner name;
- Facility name and address where appliance is located;
- Appliance ID or description;
- Appliance type;
- Refrigerant type;
- Full charge of appliance (in pounds);
- Annual percent refrigerant loss;
- Dates of refrigerant addition;
- Amounts of refrigerant added;
- Date of last successful follow-up verification test;
- Explanation of cause of refrigerant losses;
- Description of repair actions taken; and
- Whether a retrofit or retirement plan has been developed for the refrigerant-containing appliance and, if so, the anticipated date of retrofit or retirement.

Notification of Exclusion of Destroyed Purged Refrigerants from Leak Rate Calculation Requirements:

- The identification of the facility and a contact person, including the address and telephone number;
- A description of the refrigerant-containing appliance, focusing on aspects relevant to the purging of refrigerant and subsequent destruction;

- A description of the methods used to determine the quantity of refrigerant sent for destruction and type of records that are being kept by the owners or operators where the appliance is located;
- The frequency of monitoring and data-recording; and
- A description of the control device, and its destruction efficiency.

Recordkeeping Requirements:

- Upon installation of covered equipment, maintain the following information:
  - The identification of the owner or operator of the refrigerant-containing appliance;
  - The address where the appliance is located;
  - The full charge of the refrigerant-containing appliance and the method for how the full charge was determined;
  - If using method 4 (using an established range) for determining full charge, records must include the range for the full charge of the refrigerant-containing appliance, its midpoint, and how the range was determined;
  - Any revisions of the full charge, how they were determined, and the dates such revisions occurred; and
  - The date of installation.
- Maintain a record including the following information for each time a refrigerant-containing appliance with a full charge of 15 or more pounds is installed, serviced, repaired, or disposed of, when applicable:
  - The identity and location of the refrigerant-containing appliance;
  - The date of the installation, service, repair, or disposal performed;
  - The part(s) of the refrigerant-containing appliance being serviced, repaired, or disposed;
  - The type of service, repair, or disposal performed for each part;
  - The name of the person performing the installation, service, repair, or disposal;
  - The amount and type of refrigerant added to, or in the case of disposal removed from, the appliance;
  - The full charge of the refrigerant-containing appliance; and
  - The leak rate and the method used to determine the leak rate (not applicable when disposing of the appliance, following a retrofit, installing a new appliance, or if the refrigerant addition qualifies as a seasonal variance).
- Maintain a record of changes to the leak rate calculation method after a change in ownership including the following information:
  - Basic identification information (i.e., owner name or operator, facility name, facility address where appliance is located, and appliance ID or description);
  - The date an operating facility was purchased;
  - The leak rates for all refrigerant-containing appliances at the operating facility when both leak rate calculation methods are applied;
  - The date a new leak rate calculation method is adopted; and
  - The leak rate calculation method the owner or operator is using after the change.
- Maintain records of leak inspections that include:
  - The date of inspection;
  - The method(s) used to conduct the leak inspection;
  - A list of the location of each leak that was identified; and
  - A certification that all visible and accessible parts of the refrigerant-containing appliance were inspected.

- If using an automatic leak detection (ALD) system, maintain the following records:
  - Records regarding the installation and the annual audit and calibration of the system;
  - A record of each date the monitoring system identified a leak; and
  - The location of the leak.
- Maintain records of all initial and follow-up verification tests that include:
  - The location of the refrigerant-containing appliance;
  - The date(s) of the verification tests;
  - The location(s) of all repaired leaks that were tested;
  - The type(s) of verification test(s) used; and
  - The results of those tests.
- Maintain retrofit or retirement plans.
- Maintain retrofit and/or extension requests submitted to EPA.
- Maintain records documenting when a refrigerant-containing appliance was mothballed and when additional refrigerant was added to the appliance (or isolated component).
- If excluding purged refrigerants that are destroyed from annual leak rate calculations, maintain the following records to support the amount of refrigerant claimed as sent for destruction:
  - The identification of the facility and a contact person, including the address and telephone number;
  - A description of the refrigerant-containing appliance, focusing on aspects relevant to the purging of refrigerant and subsequent destruction;
  - A description of the methods used to determine the quantity of refrigerant sent for destruction and type of records that are being kept by the owners or operators where the appliance is located;
  - The frequency of monitoring and data-recording; and
  - A description of the control device, and its destruction efficiency.
- If excluding additions of refrigerant due to seasonal variance from the leak rate calculation, maintain records stating that the seasonal variance flexibility is being used and documenting the amount added and removed.
- Maintain copies of reports submitted to EPA and any responses from EPA.

Technicians for HFC Refrigerant-containing Appliances

Third-Party Reporting Requirements (provided to appliance owner or operator):

- For installation, service, repair, or disposal of an appliance, provide the following documentation:
  - The identity and location of the refrigerant-containing appliance;
  - The date of the installation, service, repair, or disposal performed;
  - The part(s) of the appliance being serviced, repaired, or disposed;
  - The type of service, repair, or disposal performed for each part;
  - The name of the person performing the installation, service, repair, or disposal;
  - The amount and type of refrigerant added to, or in the case of disposal removed from, the appliance;
  - The full charge of the refrigerant-containing appliance; and
  - The leak rate and the method used to determine the leak rate (not applicable when disposing of the appliance, following a retrofit, installing a new appliance, or if the refrigerant addition qualifies as a seasonal variance).
- For leak inspections, provide the following documentation:
  - The date of inspection;

  - The method(s) used to conduct the leak inspection;
  - A list of the location of each leak that was identified; and
  - A certification that all visible and accessible parts of the refrigerant-containing appliance were inspected.
- For initial and follow-up verification tests, provide the following documentation:
  - The location of the refrigerant-containing appliance;
  - The date(s) of the verification tests;
  - The location(s) of all repaired leaks that were tested;
  - The type(s) of verification test(s) used; and
  - The results of those tests.

Fire Suppression Equipment Fillers, Servicers, and Agent Recyclers

Annual Reporting Requirements:

- The quantity of material (the combined mass of regulated substance and contaminants) by regulated substance sold, recovered, recycled, and virgin for the purpose of installation of new equipment and servicing and/or repair of fire suppression equipment;
- The total mass of each regulated substance sold, recovered, recycled, and virgin; and
- The total mass of waste products sent for disposal, along with information about the disposal facility if waste is not processed by the reporting entity.

Recordkeeping Requirements (to be maintained for three years):

- The quantity of material (the combined mass of regulated substance and contaminants) by regulated substance sold, recovered, recycled, and virgin for the purpose of installation of new equipment and servicing and/or repair of fire suppression equipment;
- The total mass of each regulated substance sold, recovered, recycled, and virgin; and
- The total mass of waste products sent for disposal, along with information about the disposal facility if waste is not processed by the reporting entity.
- Document fire suppression training of personnel;
- Maintain an electronic copy or paper copy of the fire suppression technician training; and
- Maintain records documenting that regulated substances are recovered from the fire suppression equipment before it is sent for disposal, either by recovering the regulated substances themselves before sending the equipment for disposal or by leaving the regulated substances in the equipment and sending it for disposal to a facility.

Reclaimers

Container Labeling Requirements:

- Reclaimers certified under 40 CFR 82.164 must affix a label to any container being sold or distributed or offered for sale or distribution that contain reclaimed regulated substances to certify that the contents do not exceed 15 percent, by weight, of virgin regulated substances; and
- The label must state "The contents of this container do exceed the limit of 15 percent, by weight, on virgin regulated substance per *40 CFR 84.112(a)*."

Annual Reporting Requirements:

- Amounts and types of reclaimed HFCs intended for servicing or repair in the covered subsectors over the preceding calendar year (i.e., January 1, 2026, to December 31, 2026, and January 1, 2027, to December 31, 2027).

Recordkeeping Requirements (to be maintained for three years):

- The name, address, contact person, email address, and phone number of the reclaimer certified under 40 CFR 82.164;
- The date the container was filled with reclaimed regulated substance(s);
- The amount and name of the regulated substance(s) in the container(s);
- Certification that the contents of the container are from a batch where the amount of virgin regulated substances does not exceed 15 percent, by weight, of the total regulated substances;
- The unique serial number associated with the container(s) filled from the batch;
- Identification of the batch of reclaimed regulated substances used to fill the container(s); and
- The percent, by weight, of virgin regulated substance(s) in the batch used to fill the container(s).

Persons who Sell or Distribute or Offer for Sale or Distribution Reclaimed HFCs

Reporting Requirements:

- Reclaimers, distributors, and wholesalers of reclaimed refrigerants that contain regulated substances that are sold for the intended purpose of servicing and/or repair of refrigerant-containing equipment in the subsectors listed in 84.112 (e) must submit a report electronically, in a manner specified by EPA, containing the following information: name and address of the company; contact person, email address, and phone number of the responsible party; the quantity of reclaimed refrigerant containing regulated substances by the name and volume of reclaimed refrigerant(s); and indication of the specific subsector(s) where the reclaimed refrigerant(s) containing HFC(s) are sold.

Technicians Removing HFC Heels from Disposable Cylinders

Third-Party Reporting Requirements (provided to final processor):

- Certification by a certified technician that a disposable cylinder has been evacuated to a level of 15 in-Hg.

Final Processors Receiving Evacuated Disposable Cylinders

Recordkeeping Requirements (to be maintained for three years):

- Maintain record of the signed certification provided by a certified technician that a disposable cylinder has been evacuated to a level of 15 in-Hg.

ii) Respondent Activities

A summary of respondent activities by respondent type is provided in Table I below.

Table I. Respondent Activities by Respondent Type

Activity	Reporting Frequency
Owners and Operators of HFC Refrigerant-containing Appliances	
Submit request for relief from retrofit/retirement plan requirements	As Needed
Submit request for retrofit/retirement plan extension	As Needed
Submit chronic leak report	Annual
Submit notification that destroyed purged refrigerant was excluded from the leak rate calculation	As Needed
Maintain records	N/A
Submit leak repair extension request	As Needed
Technicians for HFC Refrigerant-containing Appliances	
Provide documentation to owners/operators of appliances	As Needed
Fire Suppression System Fillers, Servicers, and Agent Recyclers	
Submit annual report	Annual
Maintain records	N/A
Reclaimers	
Label cylinders	As Needed
Maintain records	N/A
Submit annual report on supply of reclaimed HFCs	Annual*
Distributors of HFCs	
Submit annual report on supply of reclaimed HFCs	Annual*
Technicians Handling Recovered HFCs	
Provide documentation to disposal facility	As Needed
Final Processors	
Maintain records	N/A

*This is a two-time annual report that must be submitted by February 14, 2027, and February 14, 2028.

All records and reports must comply with requirements for regulated substances in accordance with the final rule "Phasedown of Hydrofluorocarbons: Management of Certain Hydrofluorocarbons and Substitutes under Subsection (h) of the American Innovation and Manufacturing Act of 2020." Reports and records associated with the reports listed above must be kept for three years.

These recordkeeping requirements pertain to original documents that are held by companies in the normal course of conducting business, accounts of leak inspections, repairs, and retrofits, requests for extensions, and invoices. Information from these recordkeeping documents is summarized in reports. Recordkeeping requirements are designed to aid EPA in compliance monitoring, site inspection, and enforcement actions.

(b) Collection Schedule

The following information is required on a specific collection schedule:

- Fire suppression agent reports are submitted to EPA annually (by February 14);
- Chronic leak reports, when required, are submitted to EPA by March 1 following the calendar year of the ≥125 percent leak; and
- Reports on reclaimed HFC refrigerants sold or distributed for the intended purpose of servicing and/or repair of refrigerant-containing equipment in certain RACHP subsectors must be submitted by February 14, 2027, and February 14, 2028.

The remaining reports are submitted to EPA on an as-needed basis.

(c) Estimating Respondent Burden

EPA identified 26 information collection activities that are mandated by EPA's rulemaking. EPA estimated the amount of time associated with each activity based on EPA's experience collecting similar activity data on HFCs under 40 CFR part 84 and ODS under 40 CFR part 82. This analysis assumes that all respondent burden hours are incurred by owners, operators, managers, technicians, marketing staff, and graphic design staff at companies or facilities that submit reports and use applicable equipment. Table II below summarizes the number of burden hours incurred by each respondent for each information collection activity.

(d) Estimating Respondent Costs

To determine respondent costs, an average hourly wage rate of $27.55 for refrigeration and air conditioning equipment technicians, the median hourly wage rate for heating, air-conditioning, and refrigeration mechanics and installers, was derived from the Bureau of Labor Statistics (BLS) Occupational Employment and Wages Statistics, May 2023. An average hourly wage rate of $49.85 for owners/operators, the median hourly wage rate for health and safety engineers, was derived from the BLS Occupational Employment and Wage Statistics, May 2023. A 110 percent increase was added to reflect the estimated additional costs for overhead, which increased the wage rates to $57.86 and $104.69 per hour for technical staff and owners/operators, respectively. Burden hours were multiplied by the labor rate to determine respondent costs.

In addition, an average hourly wage rate of $38.48 for reclaimer technicians, the median hourly wage rate for chemical plant and system operators, was derived from the BLS Occupational Employment and Wages Statistics, May 2023. An average hourly wage rate of $56.19 for managers, the median hourly wage rate for management occupations, was derived from the BLS Occupational Employment and Wage Statistics, May 2023. An average hourly wage rate of $19.46 for clerical staff, the median hourly wage rate for general office clerks, was derived from the BLS Occupational Employment and Wages Statistics, May 2023. An average hourly wage rate of $70.08 for lawyers, the median hourly wage rate for lawyers, was derived from the BLS Occupational Employment and Wage Statistics, May 2023. An average hourly wage rate of $31.56 for distributors and wholesalers, the median hourly wage rate for sales representatives, wholesale, was derived from the BLS Occupational Employment and Wage Statistics, May 2023. An average hourly wage rate of $51.19 for disposal establishments, the median hourly wage rate for administrative services managers, was derived from the BLS Occupational Employment and Wage Statistics, May 2023. A 110 percent increase was added to reflect the estimated additional costs for overhead, which increased the wage rates to $80.81, $118.00, $40.87, $147.17, $66.28, and $107.50 per hour for reclaimer technicians, managers, clerical staff, lawyers, wholesalers, and disposal establishments, respectively. Avoided burden hours were multiplied by the labor rate to determine the reduction in respondent costs associated with this rulemaking provision.

Finally, an average hourly wage rate of $75.78 for marketing staff, the median hourly wage rate for marketing managers, was derived from the BLS Occupational Employment and Wages Statistics, May 2023. An average hourly wage rate of $28.32 for graphic design staff, the median hourly wage rate for graphic designers, was derived from the BLS Occupational Employment and Wage Statistics, May 2023. A 110 percent increase was added to reflect the estimated additional costs for overhead, and a 31.1 percent increase was added to reflect the estimated additional fringe costs, which increased the wage rates to $208.63 and $77.97 per hour for marketing staff and graphic design staff, respectively. Burden hours were multiplied by the labor rate to determine respondent costs.

Table II below summarizes annual labor and recordkeeping and reporting costs for each respondent by information collection activity, and Table III summarizes total annual costs. Costs are calculated by multiplying burden hours per response by the number of responses per year by the assumed hourly wage rates of staff. The number of responses per year are based on the reporting frequency of each activity (as outlined in Table I), market research on the affected industries, and EPA's experience collecting data under 40 CFR part 84 and 40 CFR part 82.

(e) Estimating the Respondent Universe and Total Burden and Costs

The respondent universe for this ICR is based on a review of data collected under Section 608 of the Clean Air Act, equipment modeled in EPA's Vintaging Model, and market research on the affected industries. In total, EPA estimates 781,563 unique respondents are subject to the information collection requirements outlined in this ICR. This estimate takes into account the fact that the respondent types specified in Table II are not mutually exclusive, meaning a given respondent may be subject to more than one information collection activity.

Table III summarizes the total number of respondents per activity per year as well as total burden hours and costs per year. The number of respondents per activity per year varies across the three years covered by this ICR due to the variable leak repair requirements. Total respondent burden hours and costs are derived by multiplying the number of respondents per activity by total hours and total costs per respondent per year (see Table II).

13. Estimating the Capital/Start-up and Operation/Maintenance Costs of the Collection

Respondents are not assumed to incur operations and maintenance (O&M) costs associated with the reporting and recordkeeping requirements covered by this ICR.

(a) Detailed Respondent Burden Hours and Cost Tables

Table II. Hours and Costs per Respondent Activity

Respondent Type	Activity	Affected Equipment	Responses per Respondent per Year	Labor Hours per Respondent per Year	Labor Cost per Respondent per Year
Refrigeration and Air Conditioning Equipment Owners & Operators	Prepare and submit leak repair extension requests	15-50 pounds	1	0.5	$52.34
		>50 pounds	1	0.5	$52.34
	Prepare and submit retrofit/retirement extension requests	15-50 pounds	1	0.5	$52.34
		>50 pounds	1	0.5	$52.34
	Prepare and submit requests for relief from retrofit/retirement requirements	15-50 pounds	1	0.5	$52.34
		>50 pounds	1	0.5	$52.34
	Prepare and submit chronic leak reports	15-50 pounds	1	1.0	$104.69
		>50 pounds	1	1.0	$104.69
	Prepare and submit notifications if excluding purged refrigerants that are destroyed from annual leak rate calculations	15-50 pounds	1	0.03	$2.62
		>50 pounds	1	0.03	$2.62
	Maintain purchase and service records	15-50 pounds	3	0.025	$2.62
		>50 pounds	3	0.025	$2.62
	Maintain equipment installation records	15-50 pounds	1	0.025	$2.62
		>50 pounds	1	0.025	$2.62
	Maintain records of leak rate calculation method from ownership change	15-50 pounds	1	0.025	$2.62
		>50 pounds	1	0.025	$2.62
	Maintain retrofit and/or retirement plans	15-50 pounds	1	8.0	$837.48
		>50 pounds	1	8.0	$837.48
	Maintain records documenting when the system was mothballed and when it was brought back on-line (i.e., when refrigerant was added back into the appliance or isolated component of the appliance)	15-50 pounds	1	0.025	$2.62
		>50 pounds	1	0.025	$2.62
	Maintain records of purged and destroyed refrigerant if excluding such refrigerant from the leak rate	15-50 pounds	1	0.025	$2.62
		>50 pounds	1	0.025	$2.62

	Maintain reports on the results of verification tests any time leak rate threshold is exceeded	15-50 pounds	1	0.025	$2.62
		>50 pounds	1	0.025	$2.62
	Maintain quarterly leak inspection records	IPR and CR[a] >500 pounds	4	0.017	$1.74
	Maintain annual leak inspection records	15-50 pounds	1	0.017	$1.74
		IPR and CR >50 pounds	1	0.017	$1.74
	Maintain copies of any reports submitted to EPA under the reporting requirements in this action	15-50 pounds	1	0.017	$1.74
		>50 pounds	1	0.017	$1.74
	Maintain ALD system records	>1500 pounds with direct ALD	1	0.017	$1.74
Refrigeration and Air Conditioning Equipment Technicians	Provide leak inspection records to owners/operators	15-50 pounds	0.67	0.017	$0.96
		>50 pounds	0.51	0.017	$0.96
	Provide reports on the results of verification tests any time leak rate threshold is exceeded to owners/operators	15-50 pounds	0.67	0.017	$0.96
		>50 pounds	0.51	0.017	$0.96
	Provide invoices to appliance owners/operators	15-50 pounds	2.52	0.033	$1.93
		>50 pounds	1.96	0.033	$1.93
Fire Suppression System Fillers, Servicers, and Agent Recyclers	Prepare and submit annual report	Fire Suppression Equipment	1	9.4	$984.04
	Maintain records		1	40.0	$4,187.40
HFC Reclaimers	One-time label redesign	Cylinders	1	9.0	$1,159.03
	Maintain records		1	40.0	$1,634.64
	Two-time report on reclaim use	NA	1	8.0	$646.46
Reclaim Distributors			1	8.0	$530.21
Refrigerant Technicians	Provide certification statement for cylinder evacuation	Cylinders	1	0.5	$28.93
Final Processors	Maintain record of cylinder evacuation certification statement	Cylinders	209	0.017	$1.79

[a] IPR = industrial process refrigeration; CR = commercial refrigeration

Table III. Respondent Burden and Cost Table

Respondent Type	Activity	Affected Equipment	Respondents per Activity per Year			Total Hours per Year			Total Cost per Year		
			Y1	Y2	Y3	Y1	Y2	Y3	Y1	Y2	Y3
Refrigeration and Air Conditioning Equipment Owners & Operators	Prepare and submit leak repair extension requests	15-50 pounds	215	214	212	107.7	107.1	106.0	$11,271	$11,216	$11,092
		>50 pounds	215	217	218	107.7	108.4	108.9	$11,271	$11,344	$11,396
	Prepare and submit retrofit/retirement extension requests	15-50 pounds	43	43	42	21.5	21.4	21.2	$2,254	$2,243	$2,218
		>50 pounds	43	43	44	21.5	21.7	21.8	$2,254	$2,269	$2,279
	Prepare and submit requests for relief from retrofit/retirement requirements	15-50 pounds	100	100	99	50.1	49.8	49.3	$5,241	$5,215	$5,157
		>50 pounds	77	78	78	38.6	38.9	39.1	$4,043	$4,069	$4,088
	Prepare and submit chronic leak reports	15-50 pounds	219	218	216	219	218	216	$22,926	$22,812	$22,560
		>50 pounds	169	170	171	169	170	171	$17,688	$17,802	$17,883
	Prepare and submit notifications if excluding purged refrigerants that are destroyed from annual leak rate calculations	15-50 pounds	4	4	4	0.09	0.09	0.09	$10	$10	$10
		>50 pounds	4	4	4	0.09	0.09	0.09	$10	$10	$10
	Maintain purchase and service records	15-50 pounds	266,374	265,052	262,124	18,927	18,833	18,625	$1,981,325	$1,971,496	$1,949,714
		>50 pounds	206,611	207,943	208,893	14,680	14,775	14,842	$1,536,802	$1,546,708	$1,553,779
	Maintain equipment installation records	15-50 pounds	24,850	24,727	24,454	621	618	611	$65,036	$64,713	$63,998
		>50 pounds	13,735	13,823	13,886	343	346	347	$35,945	$36,177	$36,342
	Maintain records of leak rate calculation method from ownership change	15-50 pounds	2,664	2,651	2,621	67	66	66	$6,971	$6,937	$6,860
		>50 pounds	2,066	2,079	2,089	52	52	52	$5,407	$5,442	$5,467
	Maintain retrofit and/or retirement plans	15-50 pounds	2,003	1,993	1,971	16,020	15,941	15,764	$1,677,059	$1,668,739	$1,650,302
		>50 pounds	1,545	1,555	1,562	12,360	12,439	12,496	$1,293,875	$1,302,215	$1,308,169
	Maintain records documenting when the system was mothballed and	15-50 pounds	40	40	39	1.00	1.00	0.99	$105	$104	$103

	when it was brought back on-line (i.e., when refrigerant was added back into the appliance or isolated component of the appliance)	>50 pounds	31	31	31	0.77	0.78	0.78	$81	$81	$82
	Maintain records of purged and destroyed refrigerant if excluding such refrigerant from the leak rate	15-50 pounds	4	4	4	0.09	0.09	0.09	$10	$10	$10
		>50 pounds	4	4	4	0.09	0.09	0.09	$10	$10	$10
	Maintain reports on the results of verification tests any time leak rate threshold is exceeded	15-50 pounds	200,251	199,257	197,056	5,006	4,981	4,926	$524,081	$521,481	$515,720
		>50 pounds	154,496	155,492	156,203	3,862	3,887	3,905	$404,336	$406,942	$408,803
	Maintain quarterly leak inspection records	IPR and CR >500 pounds	76,935	77,431	77,785	5,129	5,162	5,186	$536,930	$540,391	$542,862
	Maintain annual leak inspection records	15-50 pounds	200,251	199,257	197,056	3,338	3,321	3,284	$349,387	$347,654	$343,813
		IPR and CR >50 pounds	135,262	136,134	136,757	2,254	2,269	2,279	$235,999	$237,520	$238,606
	Maintain copies of any reports submitted to EPA under the reporting requirements in this action	15-50 pounds	581	578	572	9.7	9.6	9.5	$1,014	$1,009	$998
		>50 pounds	508	512	514	8.5	8.5	8.6	$887	$893	$897
	Maintain ALD system records	IPR and CR >1500 pounds with direct ALD	147	11,049	67	2	184	1	$257	$19,277	$116
Refrigeration and Air Conditioning Equipment Technicians	Provide leak inspection records to owners/operators	15-50 pounds	300,000	298,512	295,214	3,338	3,321	3,284	$193,092	$192,134	$190,011
		>50 pounds	300,000	301,934	303,314	2,575	2,592	2,603	$148,973	$149,933	$150,619
	Provide reports on the results of verification tests any time leak rate threshold is exceeded to owners/operators	15-50 pounds	300,000	298,512	295,214	3,338	3,321	3,284	$193,092	$192,134	$190,011
		>50 pounds	300,000	301,934	303,314	2,575	2,592	2,603	$148,973	$149,933	$150,619
	Provide invoices to appliance owners/operators	15-50 pounds	300,000	298,512	295,214	25,235	25,110	24,833	$1,459,993	$1,452,751	$1,436,700
		>50 pounds	300,000	301,934	303,314	19,574	19,700	19,790	$1,132,434	$1,139,734	$1,144,945
Fire Suppression System Fillers, Servicers, and Agent Recyclers	Prepare and submit annual report	HFC Fire Suppression	20	20	20	188	188	188	$19,681	$19,681	$19,681
	Maintain records		20	20	20	800	800	800	$83,748	$83,748	$83,748

HFC Reclaimers	One-time label redesign	Cylinders	37	-	-	333	-	-	$42,884	$0	$0
	Maintain records		-	37	37	-	1,480	1,480	$0	$119,596	$119,596
	Two-time report on reclaim use	NA	-	37	37	-	296	296	$0	$23,919	$23,919
Reclaim Distributors			-	10,000	10,000	-	80,000	80,000	$0	$5,302,080	$5,302,080
Refrigerant Technicians	Provide certification statement for cylinder evacuation	Cylinders	-	-	300,000	-	-	168,529	$0	$0	$9,750,261
Final Processors	Maintain record of cylinder evacuation certification statement		-	-	1,611	-	-	5,618	$0	$0	$603,891

(b) Bottom Line Respondent Burden Hours and Cost Tables

As shown in Table IV, EPA estimates the total annual hour and cost burden to all respondents to equal 222,268 hours and $17,069,893.

Table IV. Respondent Burden Summary Table

Year	Total Responses	Total Hours	Total Labor Costs
Year 1	4,445,381	141,372	$12,155,355
Year 2	4,810,033	223,029	$17,580,430
Year 3	5,115,220	396,447	$27,869,424
Annual Average	**4,790,212**	**253,616**	**$19,201,737**
Average Annual Avoided Reclaimer Burden and Costs	15,345	-31,348	-$2,131,844
Incremental ICR Burden and Costs	**4,805,557**	**222,268**	**$17,069,893**

14. Estimating Agency Costs

EPA identified seven activities incurred by the federal government associated with this data collection request. Burden associated with each activity is based on EPA's experience with reporting and data collection of HFCs and ODS. The number of occurrences of each activity is based on the estimated number of responses per year for each year of this ICR (as discussed further in section (d) below).

The average hourly rates for EPA clerical, technical, and managerial staff of $39.66, $56.52, and $78.56, respectively, are derived from the 2024 annual base pay table, which was retrieved from the Office of Personnel Management website. The rate for clerical staff is based on a GS-11 step 1 salary, the rate for technical staff is based on a GS-13 step 1 salary, and the rate for managerial staff is based on a GS-15 step 1 salary. These rates were then multiplied by the standard government benefits multiplication factor of 1.6 to get hourly rates of $63.46 for clerical staff, $90.43 for technical staff, and $125.70 for managerial staff.

The cost of contractor time is valued at $137.13 per hour on average, including overhead and fringe. This rate takes into account a weighted average of managerial and technical staff hours, based on rates for Senior Technical Analyst III and Consultant I approved under EPA Contract #68HERH19D0029.

Table V summarizes total agency burden and costs by activity.

(a) Detailed Agency Burden Hours and Cost Tables

Table V. Agency Burden and Cost Table

Activity	Agency Hours per Activity	Number of Activities			Total Hours			Total Cost		
		Y1	Y2	Y3	Y1	Y2	Y3	Y1	Y2	Y3
Review leak repair extension requests	0.25	431	431	430	108	108	107	$9,737	$9,744	$9,713
Review retrofit/retirement extension requests	1.0	86	86	86	86	86	86	$7,789	$7,795	$7,770
Review requests for relief from retrofit/retirement requirements	0.08	177	177	177	15	15	15	$1,337	$1,337	$1,331
Review chronic leak reports	0.5	388	388	386	194	194	193	$17,542	$17,542	$17,468
Review notifications if excluding purged refrigerants that are destroyed from annual leak rate calculations	0.5	7	8	7	4	4	4	$339	$339	$338
Review annual fire suppression reports	0.5	20	20	20	10	10	10	$904	$904	$904
Review two-time report on reclaimed HFCs sold for use in servicing/repair in covered subsectors.	0.5	-	10,037	10,037	-	5,019	5,019	$0	$453,833	$453,833

(b) Bottom Line Agency Burden Hours and Costs Tables

As shown in Table VI, EPA estimates the average annual hour and cost burden to the Agency to average 3,664 hours and $332,296.

Table VI. Agency Burden Summary Table

Year	Total Hours	Total Costs
Year 1	416	$37,648
Year 2	5,435	$491,494
Year 3	5,433	$491,358
Annual Average	**3,762**	**$340,167**
Average Annual Avoided Reclaimer Burden and Costs	-98	-$7,871
Annual Average with Avoided Burden and Costs	**3,664**	**$332,296**

15. Change in Burden

This is a new information collection request.

16. Publication of Collected Information

EPA does not intend to publish data reported under this ICR.

17. Approval to Omit OMB Expiration Date

Omission of the expiration date is not requested.

18. Exceptions to Certification for Paperwork Reduction Act Submissions

There are no exceptions for the Paperwork Reduction Act submissions.

Template for ROCIS' Accounting Statement for Economically Significant Rules

(provided by OMB on 02/06/09)

Category	Estimates: Primary Estimate	Low Estimate	High Estimate	Units: Year Dollar	Discount Rate	Period Covered	Notes
Benefits							
Annualized Monetized ($millions/year)	$0.00				7%		Incremental changes (relative to prior AIM Act rulemakings) due to this rulemaking. Benefits due to reduction in climate damages using social cost of GHG. More details on discount rates used and social cost of GHG methodology can be found in the RIA addendum for this rulemaking.
	$480.0			2022	3%	2026-2050	
Annualized Quantified					7%		
					3%		
Qualitative							
Costs							
Annualized Monetized ($millions/year)	$76.00			2022	7%	2026-2050	Details on cost estimates and underlying methodology can be found in RIA addendum for this rulemaking.
	$77.00			2022	3%	2026-2050	
	$77.00			2022	2%	2026-2050	
Annualized Quantified					7%		
					3%		
Qualitative							
Transfers							

Federal Annualized Monetized ($millions/year)					7%						
					3%						
From/To	From:			To:							
Other Annualized Monetized ($millions/year)					7%						
					3%						
From/To	From:			To:							
Effects											
State, Local, and/or Tribal Government											
Small Business	Presumed no SISNOSE from screening analysis.										
Wages											
Growth											

Template for Accounting Statement for Economically Significant Rules (with calculations)

(provided by OMB on 02/06/09)

Category	Estimates: Primary Estimate	Estimates: Low Estimate	Estimates: High Estimate	Units: Year Dollar	Units: Discount Rate	Units: Period Covered	Notes
Benefits							
Annualized Monetized ($millions/year)	0.0	0.0	0.0		7%	2026-2050	Incremental changes (relative to prior AIM Act rulemakings) due to this rulemaking. Benefits due to reduction in climate damages using social cost of GHG. More details on discount rates used and social cost of GHG methodology can be found in the RIA addendum for this rulemaking.
	$ 480	0.0	0.0	2022	3%	2026-2050	
	0.0	0.0	0.0		2%	2026-2050	
Annualized Quantified	$0	0.0	0.0				
	$0	0.0	0.0				
Qualitative							
Costs							
Annualized Monetized ($millions/year)	$ 76	0.0	0.0	2022	7%	2026-2050	Details on cost estimates and underlying methodology can be found in RIA addendum for this rulemaking.
	$ 77	0.0	0.0	2022	3%	2026-2050	
	$ 77	0.0	0.0	2022	2%	2026-2050	
Annualized Quantified	0.0	0.0	0.0				
	0.0	0.0	0.0				
Qualitative							
Transfers							
Federal Annualized Monetized ($millions/year)	0.0	0.0	0.0		7%		
	0.0	0.0	0.0		3%		Enter the red cells into the ROCIS sheets
From/To	From:			To:			
Other Annualized Monetized ($millions/year)	0.0	0.0	0.0		7%		
	0.0	0.0	0.0		3%		
From/To	From:			To:			
Effects							
State, Local, and/or Tribal Government							
Small Business							
Wages							
Growth							

Example 1

PPS rule which increases Medicare payments to home health agencies by $250 million in 2005

Category	Estimates: Primary Estimate	Low Estimate	High Estimate	Units: Year Dollar	Discount Rate	Period Covered	Notes
Benefits							
Annualized Monetized ($millions/year)	0.0	0.0	0.0		7%		
	0.0	0.0	0.0		3%		
Annualized Quantified	0.0	0.0	0.0		7%		
	0.0	0.0	0.0		3%		
Qualitative							
Costs							
Annualized Monetized ($millions/year)	0.0	0.0	0.0		7%		
	0.0	0.0	0.0		3%		
Annualized Quantified	0.0	0.0	0.0		7%		
	0.0	0.0	0.0		3%		
Qualitative							
Transfers							
Federal Annualized Monetized ($millions/year)	250.0	0.0	0.0	2005	7%	2005	
	250.0	0.0	0.0	2005	3%	2005	
From/To	From:	Medicare		To:	Home Health Agenci		
Other Annualized Monetized ($millions/year)	0.0	0.0	0.0		7%		
	0.0	0.0	0.0		3%		
From/To	From:			To:			
Effects							
State, Local, and/or Tribal Government	N/A						
Small Business	N/A						
Wages	N/A						
Growth	N/A						

Example 2

Conditions of participation change which imposes a cost on providers of $100M (with a 10% uncertainty) in the first year and $30 million (10% uncertainty) for following years. Monetized benefits are $50M (15% uncertainty) in first year, growing by 10% p.a. Quantified benefits are a reduction in deaths due to infection of 100 the second year (uncertainty of 10%), growing by 10% per year. Qualititive benefits are an increase in provider flexibility and an unquantifiable increase in patient safety. Period covered is 5 years.

Category	Estimates Primary Estimate	Low Estimate	High Estimate	Units Year Dollar	Discount Rate	Period Covered	Notes
Benefits							
Annualized Monetized ($millions/year)	60.3	51.2	69.3	2005	7%	2005-2009	
	60.7	51.6	69.8	2005	3%	2005-2009	
Annualized Quantified	88.9	80.0	97.7		7%		
	91.1	82.0	100.2		3%		Reduction in deaths due to infection
Qualitative	Increased patient safety and increased provider flexibility						
Costs							
Annualized Monetized ($millions/year)	46.0	41.4	50.6	2005	7%	2005-2009	
	44.8	40.4	49.3	2005	3%	2005-2009	
Annualized Quantified	0.0	0.0	0.0		7%		
	0.0	0.0	0.0		3%		
Qualitative							
Transfers							
Federal Annualized Monetized ($millions/year)	0.0	0.0	0.0		7%		
	0.0	0.0	0.0		3%		
From/To	From:			To:			
Other Annualized Monetized ($millions/year)	0.0	0.0	0.0		7%		
	0.0	0.0	0.0		3%		
From/To	From:			To:			
Effects							
State, Local, and/or Tribal Government	N/A						
Small Business	N/A						
Wages	N/A						
Growth	N/A						

README

File prepared by Corinne Hartin, Climate Change Division, 4/30/2024

This file contains the global climate driven benefits using updated EPA 2024 SC-HFC values

These updated SC-HFC values are presented in Appendix J of the ER&R Rule Regulatory Impact Analysis Ad

Updated 2024 EPA values from: schfc_annual.csv (from Bryan Parthum, National Center for Environmental Ec

Rule-specific emissions reductions by category of rule provision (cylinder management, fire suppression, leak

Each tab contains the calculation for the total net benefits associated with each GHG

Updated EPA SC-GHG values are in 2020 dollar years and are inflated to 2022 $ years using price inflator: 1.12
GDP 117.973 (2022) and 105.381 (2020)

Total Benefits from all GHG's are on the 'Total Benefits' tab

PV year end = 2050
discount year = 2024

ldendum

onomics, 4/22/2024)

repair/ALD) were sent by Thomas Cyrs, Stratospheric Protection Division, on April 16th 2024

! from BEA table 1.9

Global (Updated 2024 EPA) Total Rule Benefits (by gas and provision)

Present Value -- Sum of Discounted Benefits (or PV) for HFC-32, HFC134a, HFC236fa, HFC245fa, HFC125, HFC

	Millions (in 2022 USD, discounted back to 2024) -- 2.5% Discount Rate				Millions (in 2022 USD, disco Discou	
	Cylinder	**Fire**	**LR-ALD**	**Total**	**Cylinder**	**Fire**
HFC32	$1,122.97	$0.00	$408.07	$1,531.05	$1,469.69	$0.00
HFC-134a	$310.47	$0.00	$1,459.05	$1,769.52	$412.47	$0.00
HFC-236fa	$0.00	$0.00	$0.21	$0.21	$0.00	$0.00
HFC-245fa	$0.65	$0.00	$23.81	$24.46	$0.85	$0.00
HFC-125	$1,039.65	$8.09	$3,425.65	$4,473.39	$1,430.18	$11.24
HFC-143a	$422.52	$0.00	$2,995.57	$3,418.09	$605.55	$0.00
HFC227ea	$0.00	$10.81	$0.00	$10.81	$0.00	$15.39
HFC-23	$0.00	$0.93	$0.00	$0.93	$0.00	$1.53
Total	**$2,896.26**	**$19.82**	**$8,312.36**	**$11,228.45**	**$3,918.73**	**$28.16**

Equivalent Annual Values (EAV)

	Millions (in 2022 USD, discounted back to 2024) -- 2.5% Discount Rate				Millions (in 2022 USD, disco Discou	
	Cylinder	**Fire**	**LR-ALD**	**Total**	**Cylinder**	**Fire**
HFC32	$60.95	$0.00	$22.15	$83.10	$75.28	$0.00
HFC-134a	$16.85	$0.00	$79.19	$96.04	$21.13	$0.00
HFC-236fa	$0.00	$0.00	$0.01	$0.01	$0.00	$0.00
HFC-245fa	$0.04	$0.00	$1.29	$1.33	$0.04	$0.00
HFC-125	$56.43	$0.44	$185.93	$242.80	$73.25	$0.49
HFC-143a	$22.93	$0.00	$162.59	$185.52	$31.02	$0.00
HFC227ea	$0.00	$0.59	$0.00	$0.59	$0.00	$0.67
HFC-23	$0.00	$0.05	$0.00	$0.05	$0.00	$0.07
Total	**$157.20**	**$1.08**	**$451.16**	**$609.43**	**$200.72**	**$1.22**

Year-Specific Discounted Benefits (total across all HFCs)

	Millions (in 2022 USD, discounted back to 2024) -- 2.5% Discount Rate				Millions (in 2022 USD, disco Discou	
Year	**Cylinder**	**Fire**	**LR-ALD**	**Total**	**Cylinder**	**Fire**
2024	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2025	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2026	$0.00	$0.63	$491.81	$492.44	$0.00	$0.86
2027	$0.00	$0.64	$561.84	$562.48	$0.00	$0.89
2028	$202.02	$0.66	$549.87	$752.55	$271.44	$0.91
2029	$194.05	$0.68	$537.31	$732.03	$261.00	$0.94
2030	$185.34	$0.69	$523.61	$709.64	$249.56	$0.96
2031	$177.01	$0.71	$511.46	$689.18	$238.51	$0.99
2032	$168.52	$0.73	$497.96	$667.21	$227.23	$1.01
2033	$160.24	$0.74	$485.18	$646.17	$216.25	$1.04
2034	$151.20	$0.76	$468.18	$620.13	$204.16	$1.06

	2035	$141.89	$0.77	$438.61	$581.28	$191.68	$1.08
	2036	$132.47	$0.78	$410.09	$543.35	$178.98	$1.10
	2037	$123.68	$0.80	$380.74	$505.22	$167.14	$1.12
	2038	$116.34	$0.81	$350.49	$467.64	$157.27	$1.14
	2039	$110.57	$0.82	$319.35	$430.74	$149.53	$1.16
	2040	$106.75	$0.83	$287.43	$395.01	$144.49	$1.18
	2041	$103.05	$0.84	$260.80	$364.69	$139.56	$1.20
	2042	$99.39	$0.85	$224.17	$324.41	$134.68	$1.22
	2043	$96.14	$0.86	$191.50	$288.50	$130.37	$1.24
	2044	$93.73	$0.87	$166.10	$260.70	$127.23	$1.25
	2045	$91.66	$0.88	$144.87	$237.41	$124.57	$1.27
	2046	$90.37	$0.89	$126.66	$217.92	$123.07	$1.28
	2047	$89.22	$0.89	$111.24	$201.35	$121.76	$1.29
	2048	$88.22	$0.90	$98.75	$187.87	$120.69	$1.31
	2049	$87.39	$0.90	$89.55	$177.84	$119.86	$1.32
	2050	$87.00	$0.90	$84.79	$172.69	$119.70	$1.33
Total		$2,896.26	$19.82	$8,312.36	$11,228.45	$3,918.73	$28.16

Year-Specific Undiscounted Benefits (total across all HFCs)

	Millions (in 2022 USD) -- 2.5% Discount Rate				**Millions (in 2022 USD)**	
Year	**Cylinder**	**Fire**	**LR-ALD**	**Total**	**Cylinder**	**Fire**
2024	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2025	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2026	$0.00	$0.68	$529.63	$530.30	$0.00	$0.92
2027	$0.00	$0.71	$620.16	$620.87	$0.00	$0.96
2028	$228.56	$0.75	$622.13	$851.44	$299.69	$1.01
2029	$225.04	$0.78	$623.11	$848.93	$293.92	$1.05
2030	$220.31	$0.82	$622.40	$843.53	$286.66	$1.10
2031	$215.67	$0.86	$623.16	$839.70	$279.45	$1.16
2032	$210.46	$0.91	$621.89	$833.25	$271.56	$1.21
2033	$205.12	$0.95	$621.08	$827.15	$263.61	$1.26
2034	$198.38	$0.99	$614.30	$813.67	$253.85	$1.32
2035	$190.83	$1.04	$589.88	$781.75	$243.10	$1.37
2036	$182.62	$1.08	$565.32	$749.01	$231.53	$1.43
2037	$174.76	$1.13	$537.98	$713.87	$220.54	$1.48
2038	$168.50	$1.17	$507.61	$677.28	$211.66	$1.54
2039	$164.14	$1.22	$474.08	$639.44	$205.27	$1.60
2040	$162.43	$1.26	$437.36	$601.06	$202.32	$1.65
2041	$160.72	$1.31	$406.75	$568.79	$199.33	$1.71
2042	$158.89	$1.36	$358.37	$518.62	$196.20	$1.78
2043	$157.54	$1.41	$313.79	$472.74	$193.73	$1.84
2044	$157.43	$1.46	$278.98	$437.87	$192.84	$1.90
2045	$157.80	$1.51	$249.41	$408.71	$192.59	$1.96
2046	$159.47	$1.56	$223.51	$384.54	$194.06	$2.02
2047	$161.38	$1.61	$201.20	$364.19	$195.85	$2.08

	2048	$163.56	$1.66	$183.07	$348.29	$198.00	$2.14
	2049	$166.07	$1.71	$170.16	$337.95	$200.58	$2.20
	2050	$169.46	$1.76	$165.16	$336.37	$204.31	$2.26
Total		$4,159.14	$29.72	$11,160.50	$15,349.35	$5,230.67	$38.97

:143a, HFC227ea, HFC23

unted back to 2024) -- 2.0% nt Rate			Millions (in 2022 USD, discounted back to 2024) -- 1.5% Discount Rate			
LR-ALD	Total		Cylinder	Fire	LR-ALD	Total
$532.13	$2,001.82		$2,022.97	$0.00	$731.04	$2,754.02
$1,925.96	$2,338.42		$574.32	$0.00	$2,669.10	$3,243.42
$0.34	$0.34		$0.00	$0.00	$0.56	$0.56
$31.05	$31.90		$1.16	$0.00	$42.63	$43.80
$4,703.15	$6,144.56		$2,053.93	$16.27	$6,743.62	$8,813.81
$4,284.99	$4,890.54		$904.87	$0.00	$6,392.90	$7,297.77
$0.00	$15.39		$0.00	$22.84	$0.00	$22.84
$0.00	$1.53		$0.00	$2.62	$0.00	$2.62
$11,477.60	**$15,424.50**		**$5,557.26**	**$41.73**	**$16,579.86**	**$22,178.84**

unted back to 2024) -- 2.0% nt Rate			Millions (in 2022 USD, discounted back to 2024) -- 1.5% Discount Rate			
LR-ALD	Total		Cylinder	Fire	LR-ALD	Total
$27.26	$102.53		$97.64	$0.00	$35.28	$132.92
$98.65	$119.78		$27.72	$0.00	$128.82	$156.54
$0.02	$0.02		$0.00	$0.00	$0.03	$0.03
$1.59	$1.63		$0.06	$0.00	$2.06	$2.11
$240.90	$314.64		$99.13	$0.79	$325.47	$425.39
$219.48	$250.50		$43.67	$0.00	$308.54	$352.22
$0.00	$0.67		$0.00	$1.10	$0.00	$1.10
$0.00	$0.07		$0.00	$0.13	$0.00	$0.13
$587.89	**$789.83**		**$268.21**	**$2.01**	**$800.20**	**$1,070.43**

unted back to 2024) -- 2.0% nt Rate			Millions (in 2022 USD, discounted back to 2024) -- 1.5% Discount Rate			
LR-ALD	Total		Cylinder	Fire	LR-ALD	Total
$0.00	$0.00		$0.00	$0.00	$0.00	$0.00
$0.00	$0.00		$0.00	$0.00	$0.00	$0.00
$668.06	$668.92		$0.00	$1.25	$953.15	$954.40
$764.58	$765.47		$0.00	$1.29	$1,092.20	$1,093.49
$749.24	$1,021.59		$383.55	$1.32	$1,071.14	$1,456.01
$733.29	$995.23		$369.01	$1.36	$1,049.49	$1,419.86
$715.95	$966.47		$353.10	$1.40	$1,026.11	$1,380.61
$700.50	$940.00		$337.55	$1.44	$1,005.14	$1,344.13
$683.31	$911.55		$321.69	$1.48	$981.85	$1,305.02
$667.24	$884.52		$306.30	$1.51	$960.38	$1,268.19
$645.21	$850.44		$289.27	$1.55	$930.19	$1,221.02

$605.81	$798.58	$271.63	$1.59	$874.94	$1,148.16
$567.78	$747.86	$253.62	$1.62	$821.60	$1,076.85
$528.46	$696.73	$236.85	$1.66	$766.29	$1,004.80
$487.72	$646.14	$222.87	$1.69	$708.75	$933.31
$445.57	$596.27	$211.93	$1.72	$648.96	$862.61
$402.13	$547.79	$204.88	$1.75	$587.03	$793.66
$365.81	$506.57	$197.91	$1.78	$535.15	$734.84
$315.18	$451.08	$191.00	$1.82	$461.97	$654.79
$269.80	$401.41	$184.93	$1.85	$396.10	$582.88
$234.31	$362.79	$180.56	$1.88	$344.29	$526.72
$204.58	$330.42	$176.91	$1.90	$300.82	$479.64
$179.03	$303.38	$175.01	$1.93	$263.40	$440.34
$157.32	$280.38	$173.44	$1.95	$231.52	$406.92
$139.71	$261.71	$172.22	$1.98	$205.61	$379.81
$126.75	$247.93	$171.40	$2.00	$186.56	$359.95
$120.24	$241.26	$171.61	$2.02	$177.23	$350.86
$11,477.60	$15,424.50	$5,557.26	$41.73	$16,579.86	$22,178.84

-- 2.0% Discount Rate		Millions (in 2022 USD) -- 1.5% Discount Rate			
LR-ALD	Total	Cylinder	Fire	LR-ALD	Total
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
$708.95	$709.87	$0.00	$1.31	$996.69	$997.99
$827.60	$828.56	$0.00	$1.36	$1,159.22	$1,160.59
$827.22	$1,127.92	$413.20	$1.42	$1,153.92	$1,568.54
$825.81	$1,120.79	$403.49	$1.49	$1,147.56	$1,552.54
$822.41	$1,110.17	$391.88	$1.55	$1,138.83	$1,532.26
$820.75	$1,101.36	$380.25	$1.62	$1,132.28	$1,514.15
$816.62	$1,089.39	$367.82	$1.69	$1,122.63	$1,492.14
$813.36	$1,078.23	$355.48	$1.76	$1,114.55	$1,471.79
$802.24	$1,057.41	$340.75	$1.83	$1,095.72	$1,438.29
$768.32	$1,012.79	$324.77	$1.90	$1,046.09	$1,372.76
$734.48	$967.44	$307.78	$1.97	$997.06	$1,306.81
$697.29	$919.32	$291.74	$2.04	$943.89	$1,237.66
$656.41	$869.62	$278.63	$2.11	$886.10	$1,166.85
$611.68	$818.55	$268.93	$2.18	$823.52	$1,094.64
$563.07	$767.04	$263.89	$2.26	$756.11	$1,022.26
$522.47	$723.51	$258.73	$2.33	$699.62	$960.69
$459.16	$657.14	$253.45	$2.41	$613.01	$868.87
$400.91	$596.47	$249.07	$2.49	$533.49	$785.05
$355.13	$549.87	$246.83	$2.56	$470.66	$720.06
$316.28	$510.83	$245.47	$2.64	$417.41	$665.53
$282.31	$478.40	$246.49	$2.72	$370.96	$620.16
$253.04	$450.98	$247.94	$2.79	$330.95	$581.69

$229.22	$429.35	$249.88	$2.87	$298.33	$551.09
$212.11	$414.89	$252.42	$2.94	$274.74	$530.11
$205.24	$411.81	$256.53	$3.02	$264.92	$524.46
$14,532.08	$19,801.71	$6,895.43	$53.26	$19,788.28	$26,736.97

Dollar Years = 2022 1.11949

Dollar Units = 1000000.00

Discount Rate = **1.5%**

Discount Rate **1.5% Ramsey**

	year	**HFC-32**	**HFC-134a**	**HFC-236fa**	**HFC-245fa**	**HFC-125**
		rule emission reductions (metric t				
1	2024	0	0	0	0	0
2	2025	0.00	0.00	0.00	0.00	0.00
3	2026	0.00	0.00	0.00	0.00	0.00
4	2027	0.00	0.00	0.00	0.00	0.00
5	2028	679.90	203.46	0.00	0.44	331.51
6	2029	686.31	190.60	0.00	0.44	312.41
7	2030	692.94	176.22	0.00	0.45	291.99
8	2031	699.64	161.11	0.00	0.45	270.96
9	2032	706.41	147.64	0.00	0.45	249.30
10	2033	712.86	135.89	0.00	0.46	227.41
11	2034	720.18	125.91	0.00	0.46	204.26
12	2035	727.84	117.96	0.00	0.47	180.42
13	2036	735.72	112.13	0.00	0.47	156.04
14	2037	742.98	108.57	0.00	0.47	131.11
15	2038	749.48	104.58	0.00	0.48	111.87
16	2039	755.23	100.17	0.00	0.48	98.57
17	2040	759.49	95.36	0.00	0.48	92.55
18	2041	763.95	90.43	0.00	0.48	86.39
19	2042	768.50	85.48	0.00	0.48	80.36
20	2043	772.61	81.44	0.00	0.43	75.43
21	2044	775.68	79.35	0.00	0.34	72.64
22	2045	778.34	77.56	0.00	0.22	70.41
23	2046	779.97	76.07	0.00	0.12	69.18
24	2047	781.38	74.83	0.00	0.05	68.18
25	2048	782.55	73.84	0.00	0.01	67.42
26	2049	783.43	73.14	0.00	0.00	66.92
27	2050	783.87	72.78	0.00	0.00	66.54
	PV or total					
	EAV					

Discount Rate = **2%**

Discount Rate **2.0% Ramsey**

year **rule emission reductions (metric t**

		HFC-32	HFC-134a	HFC-236fa	HFC-245fa	HFC-125
1	2024	0	0	0	0	0
2	2025	0	0	0	0	0
3	2026	0	0	0	0	0
4	2027	0	0	0	0	0
5	2028	679.8962348	203.45503	0	0.43769041	331.5146
6	2029	686.3104741	190.59896	0	0.4419194	312.409
7	2030	692.9412833	176.21603	0	0.44550557	291.986
8	2031	699.6409302	161.10533	0	0.44907361	270.962
9	2032	706.4075913	147.63897	0	0.45281129	249.3008
10	2033	712.8614423	135.8924	0	0.45640811	227.4106
11	2034	720.1772933	125.91351	0	0.46068287	204.2607
12	2035	727.8368903	117.95569	0	0.4651247	180.4186
13	2036	735.7249509	112.12713	0	0.4696156	156.0386
14	2037	742.979895	108.57482	0	0.47406135	131.1054
15	2038	749.4812571	104.57885	0	0.47732061	111.8712
16	2039	755.2300975	100.17182	0	0.47939962	98.5733
17	2040	759.4861602	95.357317	0	0.48009532	92.55087
18	2041	763.9468937	90.427773	0	0.48082457	86.39331
19	2042	768.5004959	85.476754	0	0.48140786	80.36043
20	2043	772.6128142	81.442179	0	0.43471801	75.42865
21	2044	775.6846154	79.348295	0	0.34006703	72.64011
22	2045	778.3350253	77.559846	0	0.22055579	70.40983
23	2046	779.9735563	76.072435	0	0.12290349	69.18064
24	2047	781.3809847	74.831696	0	0.05093886	68.18111
25	2048	782.5464931	73.842645	0	0.01146566	67.41864
26	2049	783.4262644	73.144813	0	0.00385962	66.92277
27	2050	783.8701035	72.782107	0	0	66.53757
	PV or total					
	EAV					

Discount Rate = 2.5%

Discount Rate 2.5% Ramsey

	year			**rule emission reductions (metric t**		
		HFC-32	**HFC-134a**	**HFC-236fa**	**HFC-245fa**	**HFC-125**
1	2024	0	0	0	0	0
2	2025	0	0	0	0	0
3	2026	0	0	0	0	0
4	2027	0	0	0	0	0

5	2028	679.8962348	203.45503	0	0.43769041	331.5146
6	2029	686.3104741	190.59896	0	0.4419194	312.409
7	2030	692.9412833	176.21603	0	0.44550557	291.986
8	2031	699.6409302	161.10533	0	0.44907361	270.962
9	2032	706.4075913	147.63897	0	0.45281129	249.3008
10	2033	712.8614423	135.8924	0	0.45640811	227.4106
11	2034	720.1772933	125.91351	0	0.46068287	204.2607
12	2035	727.8368903	117.95569	0	0.4651247	180.4186
13	2036	735.7249509	112.12713	0	0.4696156	156.0386
14	2037	742.979895	108.57482	0	0.47406135	131.1054
15	2038	749.4812571	104.57885	0	0.47732061	111.8712
16	2039	755.2300975	100.17182	0	0.47939962	98.5733
17	2040	759.4861602	95.357317	0	0.48009532	92.55087
18	2041	763.9468937	90.427773	0	0.48082457	86.39331
19	2042	768.5004959	85.476754	0	0.48140786	80.36043
20	2043	772.6128142	81.442179	0	0.43471801	75.42865
21	2044	775.6846154	79.348295	0	0.34006703	72.64011
22	2045	778.3350253	77.559846	0	0.22055579	70.40983
23	2046	779.9735563	76.072435	0	0.12290349	69.18064
24	2047	781.3809847	74.831696	0	0.05093886	68.18111
25	2048	782.5464931	73.842645	0	0.01146566	67.41864
26	2049	783.4262644	73.144813	0	0.00385962	66.92277
27	2050	783.8701035	72.782107	0	0	66.53757
	PV or total					
	EAV					

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Updated 2024 EPA SC-HFC Values

HFC-143a	HFC-227ea	HFC-23		hfc32	hfc134a	hfc236fa	hfc245fa	hfc125
0	0	0		85027	174792	2882149	108262	503902
0.00	0.00	0.00		87991	180182	2925662	111907	516891
0.00	0.00	0.00		90955	185572	2969175	115551	529880
0.00	0.00	0.00		93919	190962	3012688	119196	542868
80.52	0.00	0.00		96883	196351	3056202	122841	555857
75.63	0.00	0.00		99848	201741	3099715	126486	568846
70.90	0.00	0.00		102812	207131	3143228	130131	581835
66.71	0.00	0.00		106308	213062	3186505	134305	595642
62.72	0.00	0.00		109804	218992	3229782	138480	609449
59.41	0.00	0.00		113300	224923	3273059	142655	623256
55.20	0.00	0.00		116796	230853	3316336	146830	637063
50.72	0.00	0.00		120292	236784	3359613	151004	650870
46.07	0.00	0.00		123789	242714	3402890	155179	664677
42.80	0.00	0.00		127285	248645	3446167	159354	678484
39.28	0.00	0.00		130781	254575	3489443	163529	692291
35.55	0.00	0.00		134277	260506	3532720	167704	706098
31.64	0.00	0.00		137773	266436	3575997	171878	719905
27.66	0.00	0.00		141547	272824	3624794	176353	735112
23.83	0.00	0.00		145320	279213	3673590	180827	750318
20.13	0.00	0.00		149094	285601	3722387	185302	765525
16.56	0.00	0.00		152867	291989	3771183	189776	780732
13.43	0.00	0.00		156641	298378	3819980	194251	795939
11.46	0.00	0.00		160414	304766	3868776	198725	811146
9.70	0.00	0.00		164188	311155	3917572	203200	826353
8.16	0.00	0.00		167961	317543	3966369	207674	841560
6.86	0.00	0.00		171735	323931	4015165	212149	856766
6.48	0.00	0.00		175508	330320	4063962	216623	871973

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Updated 2024 EPA SC-HFC Values

HFC-143a	HFC-227ea	HFC-23		hfc32	hfc134a	hfc236fa	hfc245fa	hfc125
0	0	0		62409	128027	1725397	79585	359179
0	0	0		65018	132666	1758319	82770	369994
0	0	0		67627	137304	1791241	85956	380810
0	0	0		70236	141942	1824163	89141	391626
80.5176222	0	0		72845	146581	1857085	92326	402442
75.6332382	0	0		75454	151220	1890007	95511	413258
70.8951277	0	0		78063	155858	1922929	98696	424074
66.7138427	0	0		81168	161004	1956457	102375	435672
62.7191733	0	0		84272	166149	1989986	106054	447269
59.4120969	0	0		87377	171295	2023514	109733	458867
55.2020526	0	0		90481	176440	2057042	113411	470464
50.718689	0	0		93586	181586	2090570	117090	482062
46.0684755	0	0		96690	186732	2124098	120769	493660
42.7966346	0	0		99795	191877	2157626	124447	505257
39.2830521	0	0		102899	197023	2191154	128126	516855
35.5527328	0	0		106004	202168	2224682	131805	528452
31.6399364	0	0		109108	207314	2258210	135484	540050
27.657069	0	0		112471	212879	2296519	139441	552900
23.8260103	0	0		115833	218445	2334827	143398	565749
20.1274319	0	0		119195	224010	2373136	147355	578599
16.5623635	0	0		122558	229576	2411444	151312	591449
13.4313013	0	0		125920	235141	2449753	155269	604299
11.4582774	0	0		129282	240707	2488061	159226	617149
9.69796806	0	0		132644	246272	2526370	163183	629998
8.15744332	0	0		136007	251838	2564678	167140	642848
6.86169673	0	0		139369	257403	2602987	171097	655698
6.47944337	0	0		142731	262969	2641295	175054	668548

on) **Updated 2024 EPA SC-HFC Values**

HFC-143a	HFC-227ea	HFC-23		hfc32	hfc134a	hfc236fa	hfc245fa	hfc125
0	0	0		48914	99229	1080961	62270	268797
0	0	0		51240	103268	1105605	65089	277896
0	0	0		53566	107307	1130249	67907	286996
0	0	0		55893	111346	1154893	70726	296096

80.5176222	0	0		58219	115385	1179536	73544	305196
75.6332382	0	0		60545	119424	1204180	76363	314296
70.8951277	0	0		62871	123463	1228824	79181	323396
66.7138427	0	0		65661	127978	1254451	82461	333234
62.7191733	0	0		68451	132493	1280077	85741	343072
59.4120969	0	0		71241	137009	1305704	89022	352910
55.2020526	0	0		74031	141524	1331330	92302	362747
50.718689	0	0		76821	146040	1356957	95582	372585
46.0684755	0	0		79611	150555	1382583	98862	382423
42.7966346	0	0		82401	155070	1408210	102142	392261
39.2830521	0	0		85191	159586	1433836	105422	402098
35.5527328	0	0		87981	164101	1459463	108702	411936
31.6399364	0	0		90771	168616	1485089	111983	421774
27.657069	0	0		93798	173506	1514626	115516	432695
23.8260103	0	0		96824	178396	1544163	119049	443616
20.1274319	0	0		99851	183286	1573700	122583	454536
16.5623635	0	0		102877	188176	1603238	126116	465457
13.4313013	0	0		105904	193066	1632775	129650	476378
11.4582774	0	0		108930	197956	1662312	133183	487299
9.69796806	0	0		111957	202846	1691849	136716	498219
8.15744332	0	0		114983	207736	1721386	140250	509140
6.86169673	0	0		118010	212625	1750923	143783	520061
6.47944337	0	0		121036	217515	1780460	147317	530982

(2020$) **GLOBAL (2022) To**

hfc143a	hfc227ea	hfc23		hfc32	hfc134a	hfc236fa	hfc245fa
899919	582565	4444348		0	0	0	0
920056	596313	4512450		0	0	0	0
940192	610062	4580553		0	0	0	0
960328	623810	4648655		0	0	0	0
980465	637559	4716757		73.7412546	44.7220662	0	0.060190878
1000601	651307	4784860		76.7150028	43.0462172	0	0.062575716
1020738	665055	4852962		79.7554834	40.8611731	0	0.064901422
1041831	679534	4920863		83.264804	38.4269773	0	0.067519625
1062925	694013	4988763		86.8348037	36.1950811	0	0.070197979
1084019	708492	5056664		90.4180929	34.2175853	0	0.072888776
1105112	722971	5124565		94.1646078	32.5407942	0	0.075724632
1126206	737449	5192466		98.014678	31.2673847	0	0.078628169
1147300	751928	5260366		101.957188	30.4667288	0	0.081582267
1168394	766407	5328267		105.87041	30.2224133	0	0.08457029
1189487	780886	5396168		109.730091	29.8043694	0	0.087382663
1210581	795365	5464068		113.52754	29.2134996	0	0.090003919
1231675	809843	5531969		117.139749	28.4424651	0	0.092377897
1255258	825949	5608539		121.055394	27.6187942	0	0.094927012
1278842	842055	5685109		125.022981	26.7180011	0	0.097453348
1302426	858161	5761679		128.956246	26.0393067	0	0.090179547
1326010	874267	5838249		132.745323	25.9372779	0	0.072248048
1349594	890373	5914819		136.487327	25.9074129	0	0.047962525
1373177	906479	5991389		140.069138	25.9545881	0	0.027342425
1396761	922585	6067959		143.623187	26.0664977	0	0.011587592
1420345	938691	6144528		147.142764	26.2500476	0	0.002665641
1443929	954797	6221098		150.618129	26.5250588	0	0.000916655
1467513	970903	6297668		154.014399	26.9140962	0	0

(2020$) **GLOBAL (2022) To**

hfc143a	hfc227ea	hfc23		hfc32	hfc134a	hfc236fa	hfc245fa
616846	405943	2672621		0	0	0	0
633091	417173	2724189		0	0	0	0
649336	428403	2775758		0	0	0	0
665581	439633	2827326		0	0	0	0
681826	450863	2878895		55.4450388	33.3861563	0	0.045238829
698070	462093	2930463		57.9726566	32.2663661	0	0.047251627
714315	473323	2982032		60.5566695	30.7464393	0	0.049223558
731508	485263	3034644		63.5741206	29.0380126	0	0.051467344
748701	497202	3087257		66.6436794	27.4611699	0	0.053760662
765894	509141	3139869		69.7304652	26.0591459	0	0.056067464
783086	521081	3192481		72.9486273	24.8707954	0	0.058489452
800279	533020	3245093		76.2544613	23.9784754	0	0.060969062
817472	544959	3297706		79.6374514	23.4395758	0	0.063491895
834665	556898	3350318		83.0053629	23.3223512	0	0.0660449
851857	568838	3402930		86.3360626	23.0664687	0	0.068464866
869050	580777	3455542		89.6234898	22.6713964	0	0.070737529
886243	592716	3508155		92.7676953	22.131098	0	0.072817505
905616	606092	3568270		96.1886953	21.5503815	0	0.075058079
924989	619467	3628386		99.6544656	20.9030875	0	0.077281685
944362	632842	3688501		103.095629	20.4238259	0	0.071712163
963735	646217	3748617		106.425856	20.3931536	0	0.057604738
983108	659592	3808732		109.718939	20.4167029	0	0.038337477
1002481	672968	3868848		112.885523	20.4991732	0	0.021907787
1021854	686343	3928963		116.030124	20.6310312	0	0.009305601
1041226	699718	3989079		119.149361	20.8184702	0	0.002145359
1060599	713093	4049194		122.231916	21.0774199	0	0.000739277
1079972	726468	4109310		125.251437	21.4264137	0	0

(2020$) **GLOBAL (2022) Tot**

hfc143a	hfc227ea	hfc23		hfc32	hfc134a	hfc236fa	hfc245fa
442666	296353	1682108		0	0	0	0
455887	305613	1720793		0	0	0	0
469108	314874	1759478		0	0	0	0
482329	324134	1798163		0	0	0	0

495550	333394	1836848		44.3126462	26.2807707	0	0.036035834
508771	342655	1875532		46.5178055	25.481937	0	0.037778643
521992	351915	1914217		48.7716122	24.3558087	0	0.039490663
536119	361848	1954494		51.4283995	23.0815805	0	0.041455909
550246	371780	1994771		54.1321732	21.8984934	0	0.04346364
564373	381713	2035048		56.8532688	20.8432092	0	0.045485294
578500	391646	2075324		59.68612	19.9490731	0	0.047602908
592626	401578	2115601		62.5942339	19.2846175	0	0.049769792
606753	411511	2155878		65.5705569	18.8984499	0	0.051974726
620880	421444	2196155		68.5377514	18.8485175	0	0.054207479
635007	431376	2236431		71.4783964	18.6835317	0	0.056332853
649134	441309	2276708		74.385535	18.4025109	0	0.058338537
663260	451242	2316985		77.1768933	18.0000252	0	0.06018661
679226	462397	2363401		80.2189652	17.5645343	0	0.062179768
695192	473552	2409816		83.3004755	17.070783	0	0.064159244
711158	484708	2456232		86.3643748	16.7108672	0	0.059656557
727124	495863	2502647		89.3354393	16.7156065	0	0.048012577
743090	507018	2549063		92.278228	16.7634362	0	0.032011889
759055	518173	2595479		95.1147105	16.8583977	0	0.01832455
775021	529329	2641894		97.9342042	16.9930896	0	0.007796305
790987	540484	2688310		100.73122	17.172729	0	0.001800207
806953	551639	2734725		103.49926	17.4107777	0	0.000621259
822919	562795	2781141		106.213317	17.7228737	0	0

tal $ benefits (millions)

hfc125	hfc143a	hfc227ea	hfc23	Total		hfc32
0	0	0	0	0		0
0	0	0	0	0		0
0	0	0	0	0		0
0	0	0	0	0		0
206.2937327	88.37783215	0	0	413.195077		68.45108103
198.9475344	84.72155841	0	0	403.492889		70.15910684
190.1875608	81.01230334	0	0	391.881422		71.86182724
180.6816015	77.80966405	0	0	380.250566		73.91509277
170.0909768	74.63168638	0	0	367.822746		75.94504549
158.6709706	72.09947184	0	0	355.479009		77.91030785
145.6758522	68.29388664	0	0	340.750865		79.93946491
131.4606994	63.94493699	0	0	324.766327		81.97824386
116.1081961	59.16994186	0	0	307.783637		84.01547712
99.5819194	55.97824059	0	0	291.737554		85.95081624
86.70164508	52.31006151	0	0	278.633549		87.76777823
77.91921519	48.1822581	0	0	268.932517		89.46322525
74.58920634	43.62666716	0	0	263.890465		90.94557421
71.09743178	38.86507039	0	0	258.731618		92.59667371
67.5006465	34.11053449	0	0	253.449616		94.21825285
64.64218651	29.34686622	0	0	249.074785		95.74619774
63.48904361	24.58608737	0	0	246.82998		97.10293152
62.73839118	20.29277955	0	0	245.473873		98.36472901
62.82086126	17.61433131	0	0	246.486261		99.45428134
63.07394279	15.16432759	0	0	247.939542		100.470727
63.51632954	12.97084352	0	0	249.88265		101.411651
64.18838064	11.09168855	0	0	252.424174		102.2728012
64.95166477	10.64486024	0	0	256.525021		103.0334366
						$2,022.97
						$97.64
						$2,022.97

tal $ benefits (millions)

hfc125	hfc143a	hfc227ea	hfc23	Total		hfc32
0	0	0	0	0		0
0	0	0	0	0		0
0	0	0	0	0		0
0	0	0	0	0		0
149.3572311	61.45890346	0	0	299.692568		50.2182799
144.5323693	59.10605554	0	0	293.924699		51.47806004
138.6193674	56.69261207	0	0	286.664312		52.71822498
132.1564206	54.63303715	0	0	279.453058		54.2598998
124.8281991	52.56891899	0	0	271.555728		55.76444971
116.8201706	50.94057658	0	0	263.606426		57.20326858
107.5800103	48.39327282	0	0	253.851195		58.66988469
97.36538429	45.43910282	0	0	243.098393		60.12612233
86.23432447	42.15965372	0	0	231.534497		61.56234013
74.15718256	39.98914594	0	0	220.540087		62.90769142
64.73026338	37.46210935	0	0	211.663369		64.14896627
58.3156518	34.58900429	0	0	205.27028		65.28585595
55.95446744	31.39125855	0	0	202.317337		66.25121501
53.47453181	28.03951824	0	0	199.328185		67.34741677
50.89631764	24.67221845	0	0	196.203371		68.40589054
48.8578485	21.27880223	0	0	193.727818		69.38040292
48.09657009	17.86900017	0	0	192.842184		70.21720593
47.63272946	14.78221889	0	0	192.588927		70.97049243
47.79636675	12.85925446	0	0	194.062225		71.58702236
48.08654148	11.09404459	0	0	195.851047		72.13842132
48.51863849	9.508661284	0	0	197.997277		72.62521393
49.12449001	8.147099884	0	0	200.581665		73.0432609
49.79891072	7.833764338	0	0	204.310526		73.38006294
						$1,469.69
						$75.28
						$1,469.69

tal $ benefits (millions)

hfc125	hfc143a	hfc227ea	hfc23	Total		hfc32
0	0	0	0	0		0
0	0	0	0	0		0
0	0	0	0	0		0
0	0	0	0	0		0

113.2665812	44.66822857	0	0	228.564263		39.16592236
109.9215153	43.07798212	0	0	225.037018		40.11215789
105.7102038	41.42862737	0	0	220.305743		41.02986183
101.0829538	40.04031295	0	0	215.674703		42.20968256
95.74788309	38.6346985	0	0	210.456712		43.34516638
89.84521965	37.53716053	0	0	205.124344		44.41368275
82.94859118	35.75023475	0	0	198.381622		45.48946496
75.25356013	33.64875718	0	0	190.830938		46.54231096
66.80304069	31.29219884	0	0	182.616221		47.56621798
57.57262262	29.74661802	0	0	174.759717		48.50603063
50.35824253	27.92569841	0	0	168.502202		49.35337078
45.45789654	25.83614143	0	0	164.140422		50.10795109
43.69991584	23.49306697	0	0	162.430088		50.72027279
41.8487295	21.03007215	0	0	160.724481		51.4336658
39.90890102	18.54284634	0	0	158.887165		52.10675621
38.38176531	16.02414163	0	0	157.540805		52.70566845
37.85091398	13.48189998	0	0	157.431872		53.18909537
37.54959779	11.1732577	0	0	157.796532		53.60116234
37.73986788	9.736724583	0	0	159.468025		53.90124376
38.02810264	8.414232884	0	0	161.377426		54.14540786
38.42709257	7.223434166	0	0	163.556276		54.33347203
38.96264958	6.198692147	0	0	166.072001		54.46490437
39.55187243	5.969185789	0	0	169.457249		54.52988805
						$1,122.97
						$60.95
						$1,122.97

GLOBAL Discounted millions of dollars of benefits at Discount Rate

hfc134a	hfc236fa	hfc245fa	hfc125	hfc143a	hfc227ea	hfc23	Total
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
41.51371968	0	0.0558728	191.494287	82.037635	0	0	383.5525962
39.3675819	0	0.0572281	181.945914	77.48144	0	0	369.0112709
36.8170117	0	0.0584779	171.364087	72.994256	0	0	353.09566
34.11205517	0	0.0599379	160.393068	69.072504	0	0	337.5526577
31.65593704	0	0.0613946	148.760248	65.272294	0	0	321.6949194
29.48417204	0	0.0628059	136.721576	62.125752	0	0	306.304614
27.62496165	0	0.0642852	123.669072	57.97695	0	0	289.2747339
26.15164731	0	0.0657636	109.952075	53.482741	0	0	271.6304712
25.10540768	0	0.067226	95.6762904	48.757631	0	0	253.6220319
24.53604442	0	0.0686583	80.8455093	45.445894	0	0	236.8469225
23.83906969	0	0.0698932	69.3484413	41.840281	0	0	222.8654638
23.02114447	0	0.0709259	61.4027601	37.969115	0	0	211.9271707
22.0823107	0	0.0717208	57.9099604	33.871101	0	0	204.8806675
21.1259357	0	0.0726108	54.3832493	29.728343	0	0	197.9068122
20.13488537	0	0.0734416	50.8689917	25.705954	0	0	191.0015253
19.33341496	0	0.0669556	47.9949113	21.78918	0	0	184.9306596
18.97306562	0	0.0528493	46.4421052	17.984672	0	0	180.5556241
18.67115209	0	0.034566	45.2147827	14.624755	0	0	176.9099851
18.42871988	0	0.0194141	44.6051408	12.506828	0	0	175.0143845
18.23465994	0	0.008106	44.1229932	10.608113	0	0	173.4445993
18.0916859	0	0.0018372	43.7758247	8.939581	0	0	172.2205798
18.01105931	0	0.0006224	43.5852279	7.5314842	0	0	171.401195
18.00514654	0	0	43.4517374	7.1212597	0	0	171.6115802
$574.32	**$0.00**	**$1.16**	**$2,053.93**	**$904.87**	**$0.00**	**$0.00**	$5,557.26
$27.72	$0.00	$0.06	$99.13	$43.67	$0.00	$0.00	$268.21
$574.32	$0.00	$1.16	$2,053.93	$904.87	$0.00	$0.00	$5,557.26

GLOBAL Discounted millions of dollars of benefits at Discount Rate

hfc134a	hfc236fa	hfc245fa	hfc125	hfc143a	hfc227ea	hfc23	Total
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
30.2388704	0	0.0409742	135.277446	55.665222	0	0	271.4407927
28.65160974	0	0.0419581	128.340608	52.484486	0	0	260.9967215
26.76662571	0	0.0428521	120.676501	49.35433	0	0	249.5585345
24.78366418	0	0.0439269	112.794232	46.628771	0	0	238.5104945
22.97827855	0	0.0449845	104.450653	43.98732	0	0	227.2256855
21.37757607	0	0.0459948	95.8332283	41.789015	0	0	216.2490832
20.0026615	0	0.0470409	86.522626	38.920921	0	0	204.1631338
18.90686423	0	0.0480737	76.771941	35.828422	0	0	191.6814238
18.1195545	0	0.0490813	66.6619376	32.590784	0	0	178.9836971
17.67542745	0	0.0500538	56.2018766	30.306775	0	0	167.1418242
17.138726	0	0.0508704	48.0955392	27.834899	0	0	157.2690009
16.5148838	0	0.0515285	42.4797924	25.196215	0	0	149.528276
15.80520163	0	0.0520035	39.9605858	22.418462	0	0	144.4874677
15.08870167	0	0.0525526	37.4406948	19.632132	0	0	139.5614974
14.34852221	0	0.0530485	34.936798	16.93577	0	0	134.6800289
13.74464934	0	0.0482602	32.8799314	14.320024	0	0	130.3732678
13.45490956	0	0.0380062	31.7329538	11.789534	0	0	127.2326097
13.2063204	0	0.0247982	30.8107088	9.5617162	0	0	124.574036
12.99967201	0	0.013893	30.3103488	8.1547723	0	0	123.0657085
12.82675542	0	0.0057855	29.8964361	6.8974059	0	0	121.7648042
12.68950028	0	0.0013077	29.573608	5.7958226	0	0	120.6854524
12.5954295	0	0.0004418	29.3557776	4.8685381	0	0	119.8634479
12.55292253	0	0	29.1752916	4.5895052	0	0	119.6977823
$412.47	**$0.00**	**$0.85**	**$1,430.18**	**$605.55**	**$0.00**	**$0.00**	$3,918.73
$21.13	$0.00	$0.04	$73.25	$31.02	$0.00	$0.00	$200.72
$412.47	$0.00	$0.85	$1,430.18	$605.55	$0.00	$0.00	$3,918.73

GLOBAL Discounted millions of dollars of benefits at Discount Rate

hfc134a	hfc236fa	hfc245fa	hfc125	hfc143a	hfc227ea	hfc23	Total
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

23.22837184	0	0.0318504	100.111153	39.480205	0	0	202.0175034
21.97299439	0	0.0325764	94.7849781	37.146009	0	0	194.0487158
20.48969516	0	0.0332221	88.9303194	34.852464	0	0	185.3355625
18.94412801	0	0.0340248	82.9634877	32.86295	0	0	177.0142727
17.53474478	0	0.0348026	76.6680456	30.935899	0	0	168.5186581
16.28268174	0	0.035533	70.186942	29.32397	0	0	160.2428093
15.20408193	0	0.0362803	63.218836	27.246855	0	0	151.195518
14.33919082	0	0.0370066	55.9552275	25.019731	0	0	141.8934673
13.7093206	0	0.0377035	48.4602869	22.699999	0	0	132.4735276
13.33960844	0	0.0383641	40.7457108	21.052491	0	0	123.6822045
12.90033514	0	0.0388959	34.770632	19.281733	0	0	116.3449667
12.39639017	0	0.0392983	30.6215725	17.403869	0	0	110.5690811
11.82952756	0	0.0395543	28.7193687	15.439527	0	0	106.7482509
11.26178061	0	0.0398675	26.8319787	13.483765	0	0	103.051058
10.6782479	0	0.0401334	24.9641237	11.599064	0	0	99.38832555
10.19815666	0	0.0364067	23.4232761	9.779068	0	0	96.14257589
9.952242845	0	0.028586	22.5359151	8.0269384	0	0	93.73277769
9.737287828	0	0.0185946	21.8112347	6.4901506	0	0	91.65843007
9.553607418	0	0.0103845	21.3870789	5.5177749	0	0	90.37008947
9.395060415	0	0.0043104	21.0248007	4.652022	0	0	89.22160137
9.262808426	0	0.000971	20.7272121	3.8962524	0	0	88.22071599
9.162155734	0	0.0003269	20.503499	3.261967	0	0	87.39285311
9.098918546	0	0	20.3059206	3.0645784	0	0	86.99930551
$310.47	**$0.00**	**$0.65**	**$1,039.65**	**$422.52**	**$0.00**	**$0.00**	$2,896.26
$16.85	$0.00	$0.04	$56.43	$22.93	$0.00	$0.00	$157.20
$310.47	$0.00	$0.65	$1,039.65	$422.52	$0.00	$0.00	$2,896.26

Dollar Years =		Dollar Units =
2022	1.11949	1000000.00

Discount Rate = **1.5%**

Discount Rate **1.5% Ramsey**

	year	**rule emission reductions (metric tor**				
		HFC-32	**HFC-134a**	**HFC-236fa**	**HFC-245fa**	**HFC-125**
1	2024	0	0	0	0	0
2	2025	0.00	0.00	0.00	0.00	0.00
3	2026	0.00	0.00	0.00	0.00	0.84
4	2027	0.00	0.00	0.00	0.00	0.86
5	2028	0.00	0.00	0.00	0.00	0.88
6	2029	0.00	0.00	0.00	0.00	0.90
7	2030	0.00	0.00	0.00	0.00	0.92
8	2031	0.00	0.00	0.00	0.00	0.94
9	2032	0.00	0.00	0.00	0.00	0.96
10	2033	0.00	0.00	0.00	0.00	0.98
11	2034	0.00	0.00	0.00	0.00	0.99
12	2035	0.00	0.00	0.00	0.00	1.01
13	2036	0.00	0.00	0.00	0.00	1.03
14	2037	0.00	0.00	0.00	0.00	1.05
15	2038	0.00	0.00	0.00	0.00	1.06
16	2039	0.00	0.00	0.00	0.00	1.08
17	2040	0.00	0.00	0.00	0.00	1.09
18	2041	0.00	0.00	0.00	0.00	1.11
19	2042	0.00	0.00	0.00	0.00	1.12
20	2043	0.00	0.00	0.00	0.00	1.14
21	2044	0.00	0.00	0.00	0.00	1.15
22	2045	0.00	0.00	0.00	0.00	1.16
23	2046	0.00	0.00	0.00	0.00	1.18
24	2047	0.00	0.00	0.00	0.00	1.19
25	2048	0.00	0.00	0.00	0.00	1.20
26	2049	0.00	0.00	0.00	0.00	1.21
27	2050	0.00	0.00	0.00	0.00	1.22
	PV or total					
	EAV					

Discount Rate = **2%**

Discount Rate **2.0% Ramsey**

	year	**rule emission reductions (metric tor**				
		HFC-32	**HFC-134a**	**HFC-236fa**	**HFC-245fa**	**HFC-125**
1	2024	0	0	0	0	0

2	2025	0	0	0	0	0
3	2026	0	0	0	0	0.8411
4	2027	0	0	0	0	0.8602
5	2028	0	0	0	0	0.87915
6	2029	0	0	0	0	0.89845
7	2030	0	0	0	0	0.91825
8	2031	0	0	0	0	0.93765
9	2032	0	0	0	0	0.9567
10	2033	0	0	0	0	0.9754
11	2034	0	0	0	0	0.99365
12	2035	0	0	0	0	1.01155
13	2036	0	0	0	0	1.029
14	2037	0	0	0	0	1.046
15	2038	0	0	0	0	1.06255
16	2039	0	0	0	0	1.07865
17	2040	0	0	0	0	1.09425
18	2041	0	0	0	0	1.10935
19	2042	0	0	0	0	1.12395
20	2043	0	0	0	0	1.13795
21	2044	0	0	0	0	1.1514
22	2045	0	0	0	0	1.1643
23	2046	0	0	0	0	1.1766
24	2047	0	0	0	0	1.18825
25	2048	0	0	0	0	1.1993
26	2049	0	0	0	0	1.20965
27	2050	0	0	0	0	1.2193
	PV or total					
	EAV					

	Discount Rate = 2.5%	**Discount Rate 2.5% Ramsey**				
	year			**rule emission reductions (metric tor**		
		HFC-32	**HFC-134a**	**HFC-236fa**	**HFC-245fa**	**HFC-125**
1	2024	0	0	0	0	0
2	2025	0	0	0	0	0
3	2026	0	0	0	0	0.8411
4	2027	0	0	0	0	0.8602
5	2028	0	0	0	0	0.87915
6	2029	0	0	0	0	0.89845
7	2030	0	0	0	0	0.91825
8	2031	0	0	0	0	0.93765
9	2032	0	0	0	0	0.9567
10	2033	0	0	0	0	0.9754
11	2034	0	0	0	0	0.99365
12	2035	0	0	0	0	1.01155

13	2036	0	0	0	0	1.029
14	2037	0	0	0	0	1.046
15	2038	0	0	0	0	1.06255
16	2039	0	0	0	0	1.07865
17	2040	0	0	0	0	1.09425
18	2041	0	0	0	0	1.10935
19	2042	0	0	0	0	1.12395
20	2043	0	0	0	0	1.13795
21	2044	0	0	0	0	1.1514
22	2045	0	0	0	0	1.1643
23	2046	0	0	0	0	1.1766
24	2047	0	0	0	0	1.18825
25	2048	0	0	0	0	1.1993
26	2049	0	0	0	0	1.20965
27	2050	0	0	0	0	1.2193
	PV or total					
	EAV					

ı) **Updated 2024 EPA SC-HFC Values (**

HFC-143a	HFC-227ea	HFC-23		hfc32	hfc134a	hfc236fa	hfc245fa	hfc125
0	0	0		85027	174792	2882149	108262	503902
0.00	0.00	0.00		87991	180182	2925662	111907	516891
0.00	1.05	0.02		90955	185572	2969175	115551	529880
0.00	1.07	0.02		93919	190962	3012688	119196	542868
0.00	1.09	0.02		96883	196351	3056202	122841	555857
0.00	1.12	0.02		99848	201741	3099715	126486	568846
0.00	1.14	0.02		102812	207131	3143228	130131	581835
0.00	1.17	0.02		106308	213062	3186505	134305	595642
0.00	1.19	0.02		109804	218992	3229782	138480	609449
0.00	1.21	0.02		113300	224923	3273059	142655	623256
0.00	1.24	0.02		116796	230853	3316336	146830	637063
0.00	1.26	0.02		120292	236784	3359613	151004	650870
0.00	1.28	0.02		123789	242714	3402890	155179	664677
0.00	1.30	0.02		127285	248645	3446167	159354	678484
0.00	1.32	0.02		130781	254575	3489443	163529	692291
0.00	1.34	0.02		134277	260506	3532720	167704	706098
0.00	1.36	0.02		137773	266436	3575997	171878	719905
0.00	1.38	0.02		141547	272824	3624794	176353	735112
0.00	1.40	0.02		145320	279213	3673590	180827	750318
0.00	1.42	0.02		149094	285601	3722387	185302	765525
0.00	1.43	0.02		152867	291989	3771183	189776	780732
0.00	1.45	0.02		156641	298378	3819980	194251	795939
0.00	1.46	0.02		160414	304766	3868776	198725	811146
0.00	1.48	0.02		164188	311155	3917572	203200	826353
0.00	1.49	0.02		167961	317543	3966369	207674	841560
0.00	1.50	0.03		171735	323931	4015165	212149	856766
0.00	1.52	0.03		175508	330320	4063962	216623	871973

ı) **Updated 2024 EPA SC-HFC Values (**

HFC-143a	HFC-227ea	HFC-23		hfc32	hfc134a	hfc236fa	hfc245fa	hfc125
0	0	0		62409	128027	1725397	79585	359179

0	0	0		65018	132666	1758319	82770	369994
0	1.05185	0.0174		67627	137304	1791241	85956	380810
0	1.07225	0.0178		70236	141942	1824163	89141	391626
0	1.09445	0.0182		72845	146581	1857085	92326	402442
0	1.1178	0.0186		75454	151220	1890007	95511	413258
0	1.1424	0.019		78063	155858	1922929	98696	424074
0	1.16655	0.0194		81168	161004	1956457	102375	435672
0	1.19025	0.0198		84272	166149	1989986	106054	447269
0	1.2135	0.02015		87377	171295	2023514	109733	458867
0	1.23625	0.02055		90481	176440	2057042	113411	470464
0	1.2585	0.0209		93586	181586	2090570	117090	482062
0	1.2802	0.0213		96690	186732	2124098	120769	493660
0	1.30135	0.02165		99795	191877	2157626	124447	505257
0	1.32195	0.022		102899	197023	2191154	128126	516855
0	1.342	0.0223		106004	202168	2224682	131805	528452
0	1.3614	0.02265		109108	207314	2258210	135484	540050
0	1.38015	0.02295		112471	212879	2296519	139441	552900
0	1.3983	0.02325		115833	218445	2334827	143398	565749
0	1.41575	0.02355		119195	224010	2373136	147355	578599
0	1.4325	0.0238		122558	229576	2411444	151312	591449
0	1.44855	0.0241		125920	235141	2449753	155269	604299
0	1.46385	0.02435		129282	240707	2488061	159226	617149
0	1.47835	0.0246		132644	246272	2526370	163183	629998
0	1.49205	0.0248		136007	251838	2564678	167140	642848
0	1.50495	0.025		139369	257403	2602987	171097	655698
0	1.517	0.0252		142731	262969	2641295	175054	668548

ı)				Updated 2024 EPA SC-HFC Values (:				
HFC-143a	**HFC-227ea**	**HFC-23**		**hfc32**	**hfc134a**	**hfc236fa**	**hfc245fa**	**hfc125**
0	0	0		48914	99229	1080961	62270	268797
0	0	0		51240	103268	1105605	65089	277896
0	1.05185	0.0174		53566	107307	1130249	67907	286996
0	1.07225	0.0178		55893	111346	1154893	70726	296096
0	1.09445	0.0182		58219	115385	1179536	73544	305196
0	1.1178	0.0186		60545	119424	1204180	76363	314296
0	1.1424	0.019		62871	123463	1228824	79181	323396
0	1.16655	0.0194		65661	127978	1254451	82461	333234
0	1.19025	0.0198		68451	132493	1280077	85741	343072
0	1.2135	0.02015		71241	137009	1305704	89022	352910
0	1.23625	0.02055		74031	141524	1331330	92302	362747
0	1.2585	0.0209		76821	146040	1356957	95582	372585

0	1.2802	0.0213		79611	150555	1382583	98862	382423
0	1.30135	0.02165		82401	155070	1408210	102142	392261
0	1.32195	0.022		85191	159586	1433836	105422	402098
0	1.342	0.0223		87981	164101	1459463	108702	411936
0	1.3614	0.02265		90771	168616	1485089	111983	421774
0	1.38015	0.02295		93798	173506	1514626	115516	432695
0	1.3983	0.02325		96824	178396	1544163	119049	443616
0	1.41575	0.02355		99851	183286	1573700	122583	454536
0	1.4325	0.0238		102877	188176	1603238	126116	465457
0	1.44855	0.0241		105904	193066	1632775	129650	476378
0	1.46385	0.02435		108930	197956	1662312	133183	487299
0	1.47835	0.0246		111957	202846	1691849	136716	498219
0	1.49205	0.0248		114983	207736	1721386	140250	509140
0	1.50495	0.025		118010	212625	1750923	143783	520061
0	1.517	0.0252		121036	217515	1780460	147317	530982

2020$) | **GLOBAL (2022) Total $ benefits (millions)**

hfc143a	hfc227ea	hfc23		hfc32	hfc134a	hfc236fa	hfc245fa	hfc125	hfc143a
899919	582565	4444348		0	0	0	0	0	0
920056	596313	4512450		0	0	0	0	0	0
940192	610062	4580553		0	0	0	0	0.498937	0
960328	623810	4648655		0	0	0	0	0.522774	0
980465	637559	4716757		0	0	0	0	0.547074	0
1000601	651307	4784860		0	0	0	0	0.572149	0
1020738	665055	4852962		0	0	0	0	0.59811	0
1041831	679534	4920863		0	0	0	0	0.625239	0
1062925	694013	4988763		0	0	0	0	0.65273	0
1084019	708492	5056664		0	0	0	0	0.680565	0
1105112	722971	5124565		0	0	0	0	0.708657	0
1126206	737449	5192466		0	0	0	0	0.737058	0
1147300	751928	5260366		0	0	0	0	0.765678	0
1168394	766407	5328267		0	0	0	0	0.794496	0
1189487	780886	5396168		0	0	0	0	0.82349	0
1210581	795365	5464068		0	0	0	0	0.85264	0
1231675	809843	5531969		0	0	0	0	0.881885	0
1255258	825949	5608539		0	0	0	0	0.91294	0
1278842	842055	5685109		0	0	0	0	0.944088	0
1302426	858161	5761679		0	0	0	0	0.975221	0
1326010	874267	5838249		0	0	0	0	1.006349	0
1349594	890373	5914819		0	0	0	0	1.037445	0
1373177	906479	5991389		0	0	0	0	1.068435	0
1396761	922585	6067959		0	0	0	0	1.099243	0
1420345	938691	6144528		0	0	0	0	1.129882	0
1443929	954797	6221098		0	0	0	0	1.160225	0
1467513	970903	6297668		0	0	0	0	1.190238	0

2020$) | **GLOBAL (2022) Total $ benefits (millions)**

hfc143a	hfc227ea	hfc23		hfc32	hfc134a	hfc236fa	hfc245fa	hfc125	hfc143a
616846	405943	2672621		0	0	0	0	0	0

633091	417173	2724189		0	0	0	0	0	0
649336	428403	2775758		0	0	0	0	0.358572	0
665581	439633	2827326		0	0	0	0	0.37713	0
681826	450863	2878895		0	0	0	0	0.396083	0
698070	462093	2930463		0	0	0	0	0.415657	0
714315	473323	2982032		0	0	0	0	0.435936	0
731508	485263	3034644		0	0	0	0	0.457321	0
748701	497202	3087257		0	0	0	0	0.479032	0
765894	509141	3139869		0	0	0	0	0.50106	0
783086	521081	3192481		0	0	0	0	0.523335	0
800279	533020	3245093		0	0	0	0	0.545897	0
817472	544959	3297706		0	0	0	0	0.568674	0
834665	556898	3350318		0	0	0	0	0.591649	0
851857	568838	3402930		0	0	0	0	0.614806	0
869050	580777	3455542		0	0	0	0	0.638126	0
886243	592716	3508155		0	0	0	0	0.661562	0
905616	606092	3568270		0	0	0	0	0.68665	0
924989	619467	3628386		0	0	0	0	0.711854	0
944362	632842	3688501		0	0	0	0	0.737091	0
963735	646217	3748617		0	0	0	0	0.762367	0
983108	659592	3808732		0	0	0	0	0.787657	0
1002481	672968	3868848		0	0	0	0	0.812904	0
1021854	686343	3928963		0	0	0	0	0.838045	0
1041226	699718	3989079		0	0	0	0	0.863091	0
1060599	713093	4049194		0	0	0	0	0.887941	0
1079972	726468	4109310		0	0	0	0	0.912564	0

2020$)						**GLOBAL (2022) Total $ benefits (millions)**			
hfc143a	**hfc227ea**	**hfc23**		**hfc32**	**hfc134a**	**hfc236fa**	**hfc245fa**	**hfc125**	**hfc143a**
442666	296353	1682108		0	0	0	0	0	0
455887	305613	1720793		0	0	0	0	0	0
469108	314874	1759478		0	0	0	0	0.270236	0
482329	324134	1798163		0	0	0	0	0.285136	0
495550	333394	1836848		0	0	0	0	0.300374	0
508771	342655	1875532		0	0	0	0	0.316121	0
521992	351915	1914217		0	0	0	0	0.332442	0
536119	361848	1954494		0	0	0	0	0.349792	0
550246	371780	1994771		0	0	0	0	0.367436	0
564373	381713	2035048		0	0	0	0	0.38536	0
578500	391646	2075324		0	0	0	0	0.403513	0
592626	401578	2115601		0	0	0	0	0.421923	0

606753	411511	2155878		0	0	0	0	0.440534	0
620880	421444	2196155		0	0	0	0	0.459332	0
635007	431376	2236431		0	0	0	0	0.478301	0
649134	441309	2276708		0	0	0	0	0.497428	0
663260	451242	2316985		0	0	0	0	0.516674	0
679226	462397	2363401		0	0	0	0	0.537367	0
695192	473552	2409816		0	0	0	0	0.55818	0
711158	484708	2456232		0	0	0	0	0.579044	0
727124	495863	2502647		0	0	0	0	0.599965	0
743090	507018	2549063		0	0	0	0	0.620922	0
759055	518173	2595479		0	0	0	0	0.641866	0
775021	529329	2641894		0	0	0	0	0.662748	0
790987	540484	2688310		0	0	0	0	0.683574	0
806953	551639	2734725		0	0	0	0	0.704262	0
822919	562795	2781141		0	0	0	0	0.724787	0

GLOBAL Discounted millions of dollars of benefits at Di:

hfc227ea	hfc23	Total		hfc32	hfc134a	hfc236fa	hfc245fa	hfc125	hfc143a
0	0	0		0	0	0	0	0	0
0	0	0		0	0	0	0	0	0
0.71837	0.089225	1.306532		0	0	0	0	0.477142	0
0.748805	0.092633	1.364212		0	0	0	0	0.492549	0
0.781154	0.096103	1.424331		0	0	0	0	0.507827	0
0.815024	0.099633	1.486805		0	0	0	0	0.523254	0
0.850543	0.103224	1.551877		0	0	0	0	0.538913	0
0.887432	0.106872	1.619543		0	0	0	0	0.555032	0
0.924754	0.11058	1.688064		0	0	0	0	0.570872	0
0.962487	0.114067	1.757119		0	0	0	0	0.58642	0
1.00057	0.117893	1.82712		0	0	0	0	0.601603	0
1.038976	0.12149	1.897524		0	0	0	0	0.616466	0
1.077642	0.125434	1.968754		0	0	0	0	0.63094	0
1.116539	0.129141	2.040176		0	0	0	0	0.645011	0
1.155641	0.132901	2.112032		0	0	0	0	0.65867	0
1.194921	0.136408	2.18397		0	0	0	0	0.671907	0
1.234261	0.140271	2.256417		0	0	0	0	0.684683	0
1.276144	0.144096	2.333181		0	0	0	0	0.698319	0
1.318139	0.147973	2.4102		0	0	0	0	0.711472	0
1.360115	0.151901	2.487237		0	0	0	0	0.724072	0
1.402036	0.155554	2.563938		0	0	0	0	0.736142	0
1.443862	0.15958	2.640887		0	0	0	0	0.747674	0
1.485507	0.163323	2.717265		0	0	0	0	0.758629	0
1.526877	0.167108	2.793228		0	0	0	0	0.768969	0
1.567929	0.170593	2.868404		0	0	0	0	0.778722	0
1.60862	0.174111	2.942956		0	0	0	0	0.787817	0
1.648852	0.177664	3.016755		0	0	0	0	0.796252	0
				$0.00	**$0.00**	**$0.00**	**$0.00**	**$16.27**	**$0.00**
				$0.00	$0.00	$0.00	$0.00	$0.79	$0.00
				$0.00	$0.00	$0.00	$0.00	$16.27	$0.00

GLOBAL Discounted millions of dollars of benefits at Di:

hfc227ea	hfc23	Total		hfc32	hfc134a	hfc236fa	hfc245fa	hfc125	hfc143a
0	0	0		0	0	0	0	0	0

0	0	0	0	0	0	0	0	0
0.50446	0.054069	0.917101	0	0	0	0	0.33789	0
0.527724	0.05634	0.961194	0	0	0	0	0.34841	0
0.552409	0.058657	1.007149	0	0	0	0	0.358745	0
0.578248	0.06102	1.054925	0	0	0	0	0.369092	0
0.605335	0.063429	1.1047	0	0	0	0	0.379509	0
0.633725	0.065907	1.156952	0	0	0	0	0.390319	0
0.662508	0.068432	1.209973	0	0	0	0	0.400833	0
0.691669	0.070828	1.263557	0	0	0	0	0.411044	0
0.72116	0.073445	1.317941	0	0	0	0	0.420899	0
0.75096	0.075927	1.372784	0	0	0	0	0.430436	0
0.78102	0.078634	1.428328	0	0	0	0	0.439604	0
0.811316	0.081202	1.484167	0	0	0	0	0.448396	0
0.841829	0.08381	1.540446	0	0	0	0	0.45681	0
0.872534	0.086266	1.596926	0	0	0	0	0.46484	0
0.903343	0.088954	1.65386	0	0	0	0	0.472463	0
0.936451	0.091677	1.714778	0	0	0	0	0.480765	0
0.969703	0.09444	1.775998	0	0	0	0	0.488639	0
1.003003	0.097244	1.837338	0	0	0	0	0.496041	0
1.036319	0.099878	1.898563	0	0	0	0	0.502991	0
1.069619	0.102759	1.960035	0	0	0	0	0.509487	0
1.102837	0.105463	2.021204	0	0	0	0	0.515508	0
1.135897	0.108202	2.082143	0	0	0	0	0.521031	0
1.168764	0.11075	2.142605	0	0	0	0	0.52608	0
1.201403	0.113326	2.202669	0	0	0	0	0.530615	0
1.233736	0.115928	2.262229	0	0	0	0	0.534637	0
			$0.00	**$0.00**	**$0.00**	**$0.00**	**$11.24**	**$0.00**
			$0.00	$0.00	$0.00	$0.00	$0.49	$0.00
			$0.00	$0.00	$0.00	$0.00	$11.24	$0.00

GLOBAL Discounted millions of dollars of benefits at Di

hfc227ea	hfc23	Total	hfc32	hfc134a	hfc236fa	hfc245fa	hfc125	hfc143a
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0.370775	0.034273	0.675285	0	0	0	0	0.250941	0
0.389082	0.035832	0.71005	0	0	0	0	0.258319	0
0.408483	0.037425	0.746282	0	0	0	0	0.265487	0
0.428787	0.039053	0.783961	0	0	0	0	0.27259	0
0.450066	0.040716	0.823224	0	0	0	0	0.279672	0
0.472552	0.042448	0.864793	0	0	0	0	0.287091	0
0.495387	0.044216	0.907039	0	0	0	0	0.294216	0
0.518558	0.045906	0.949824	0	0	0	0	0.301043	0
0.542026	0.047744	0.993283	0	0	0	0	0.307535	0
0.565775	0.049499	1.037197	0	0	0	0	0.313723	0

0.589766	0.051407	1.081707		0	0	0	0	0.319573	0
0.61398	0.053228	1.126541		0	0	0	0	0.325082	0
0.638398	0.055081	1.17178		0	0	0	0	0.330251	0
0.663003	0.056837	1.217269		0	0	0	0	0.33508	0
0.687726	0.058751	1.263151		0	0	0	0	0.339556	0
0.714433	0.060721	1.312521		0	0	0	0	0.344541	0
0.74129	0.062723	1.362194		0	0	0	0	0.349157	0
0.768223	0.064756	1.412023		0	0	0	0	0.353374	0
0.7952	0.06668	1.461846		0	0	0	0	0.357211	0
0.822199	0.068773	1.511894		0	0	0	0	0.360672	0
0.849164	0.070752	1.561782		0	0	0	0	0.363744	0
0.876039	0.072756	1.611543		0	0	0	0	0.366417	0
0.90279	0.074637	1.661		0	0	0	0	0.368713	0
0.929389	0.076537	1.710188		0	0	0	0	0.370607	0
0.955776	0.078459	1.759023		0	0	0	0	0.372106	0
				$0.00	**$0.00**	**$0.00**	**$0.00**	**$8.09**	**$0.00**
				$0.00	$0.00	$0.00	$0.00	$0.44	$0.00
				$0.00	$0.00	$0.00	$0.00	$8.09	$0.00

scount Rate

hfc227ea	hfc23	Total
0	0	0
0	0	0
0.686989	0.085328	1.249459
0.705512	0.087278	1.285339
0.725114	0.089208	1.32215
0.745373	0.091118	1.359746
0.766362	0.093008	1.398282
0.787783	0.094871	1.437686
0.808782	0.096713	1.476368
0.829344	0.098288	1.514052
0.849417	0.100084	1.551103
0.868986	0.101613	1.587066
0.888006	0.103361	1.622307
0.906461	0.104843	1.656315
0.924341	0.106301	1.689312
0.941635	0.107494	1.721036
0.958262	0.108904	1.751849
0.976138	0.110221	1.784677
0.993359	0.111513	1.816345
1.009845	0.112782	1.8467
1.025586	0.113787	1.875515
1.040574	0.115007	1.903255
1.054765	0.115965	1.929359
1.068117	0.1169	1.953986
1.080626	0.117574	1.976921
1.092286	0.118225	1.998328
1.103059	0.118855	2.018166
$22.84	**$2.62**	$41.73
$1.10	$0.13	$2.01

$22.84	$2.62	$41.73

scount Rate

hfc227ea	hfc23	Total
0	0	0

0	0	0
0.475364	0.050951	0.864205
0.487535	0.052049	0.887995
0.500334	0.053127	0.912206
0.513467	0.054184	0.936743
0.526981	0.055219	0.961708
0.540878	0.056251	0.987448
0.554357	0.057261	1.012451
0.567409	0.058104	1.036557
0.580003	0.059069	1.059971
0.592127	0.059868	1.082431
0.603754	0.060787	1.104144
0.614876	0.061541	1.124813
0.625491	0.062272	1.144574
0.635594	0.06284	1.163274
0.645134	0.063528	1.181125
0.655665	0.064189	1.200618
0.665634	0.064827	1.219099
0.674992	0.065442	1.236476
0.683738	0.065897	1.252626
0.691871	0.066468	1.267827
0.699371	0.06688	1.281758
0.706211	0.067271	1.294513
0.712398	0.067506	1.305984
0.717933	0.067721	1.316269
0.722799	0.067918	1.325354
$15.39	**$1.53**	$28.16
$0.67	$0.07	$1.22
$15.39	$1.53	$28.16

scount Rate

hfc227ea	hfc23	Total
0	0	0
0	0	0
0.344302	0.031826	0.627069
0.352489	0.032462	0.64327
0.361039	0.033078	0.659605
0.369742	0.033676	0.676007
0.378625	0.034253	0.69255
0.387846	0.034839	0.709776
0.39667	0.035405	0.726291
0.405096	0.035862	0.742001
0.413102	0.036388	0.757026
0.420685	0.036806	0.771214

0.427828	0.037292	0.784692
0.43453	0.037671	0.797283
0.440792	0.038031	0.809073
0.446615	0.038287	0.819983
0.45197	0.038611	0.830136
0.45807	0.038932	0.841544
0.463698	0.039235	0.85209
0.468824	0.039519	0.861717
0.473451	0.0397	0.870363
0.477587	0.039948	0.878206
0.481219	0.040095	0.885058
0.48434	0.040225	0.890982
0.486956	0.040258	0.895928
0.489077	0.040277	0.89996
0.490695	0.040281	0.903082
$10.81	**$0.93**	$19.82
$0.59	$0.05	$1.08
$10.81	$0.93	$19.82

Dollar Years = 2022 1.11949

Dollar Units = 1000000.00

Discount Rate = 1.5%

Discount Rate 1.5% Ramsey

	year	**rule emission reductions (metric t**				
		HFC-32	**HFC-134a**	**HFC-236fa**	**HFC-245fa**	**HFC-125**
1	2024	0	0	0	0	0
2	2025	0.00	0.00	0.00	0.00	0.00
3	2026	240.11	805.10	0.13	15.56	661.27
4	2027	278.06	876.61	0.04	15.56	758.67
5	2028	284.78	861.52	0.00	15.56	743.69
6	2029	290.76	836.58	0.00	15.56	729.01
7	2030	294.79	803.25	0.00	15.56	712.94
8	2031	296.97	769.84	0.00	15.56	696.02
9	2032	297.16	735.22	0.00	15.56	676.44
10	2033	295.38	700.39	0.00	15.56	656.41
11	2034	293.11	668.75	0.00	15.56	633.00
12	2035	283.15	624.83	0.00	15.56	589.37
13	2036	274.07	581.29	0.00	15.56	547.48
14	2037	264.99	537.02	0.00	15.56	504.89
15	2038	255.98	491.97	0.00	15.56	461.44
16	2039	247.10	446.09	0.00	15.56	417.06
17	2040	238.44	399.32	0.00	15.56	371.79
18	2041	234.61	357.20	0.00	15.56	331.66
19	2042	223.38	304.38	0.00	15.56	281.08
20	2043	215.90	258.96	0.00	14.02	238.89
21	2044	215.63	227.84	0.00	10.93	212.03
22	2045	216.63	201.36	0.00	7.03	190.78
23	2046	218.16	177.81	0.00	3.87	172.97
24	2047	220.25	158.16	0.00	1.57	158.18
25	2048	222.94	142.56	0.00	0.31	146.55
26	2049	225.63	131.67	0.00	0.11	138.53
27	2050	227.73	125.86	0.00	0.00	133.62
	PV or total					
	EAV					

Discount Rate = 2%

Discount Rate 2.0% Ramsey

	year	**rule emission reductions (metric t**				
		HFC-32	**HFC-134a**	**HFC-236fa**	**HFC-245fa**	**HFC-125**
1	2024	0	0	0	0	0

2	2025	0	0	0	0	0
3	2026	240.1107597	805.097484	0.1331252	15.5634091	661.2722983
4	2027	278.0603676	876.610797	0.0444342	15.5634091	758.6660836
5	2028	284.7788545	861.519472	0	15.5634091	743.686471
6	2029	290.7627802	836.57823	0	15.5634091	729.0145163
7	2030	294.7920325	803.247332	0	15.5634091	712.937765
8	2031	296.9736474	769.839993	0	15.5634091	696.0162247
9	2032	297.1595897	735.215278	0	15.5634091	676.4403095
10	2033	295.3782679	700.388437	0	15.5634091	656.4095867
11	2034	293.105388	668.753438	0	15.5634091	633.0027206
12	2035	283.1540655	624.825681	0	15.5634091	589.3674206
13	2036	274.0682173	581.294032	0	15.5634091	547.4758684
14	2037	264.993155	537.018676	0	15.5634091	504.8933716
15	2038	255.9787743	491.969526	0	15.5634091	461.4393431
16	2039	247.0951909	446.093069	0	15.5634091	417.0620427
17	2040	238.4428474	399.322123	0	15.5634091	371.7855933
18	2041	234.6111073	357.202557	0	15.5634091	331.6646583
19	2042	223.3780446	304.378272	0	15.5634091	281.0766351
20	2043	215.9015784	258.957559	0	14.02410662	238.8866262
21	2044	215.6344772	227.842784	0	10.93010865	212.0260552
22	2045	216.6304716	201.355456	0	7.027883789	190.7827063
23	2046	218.1611885	177.812976	0	3.87193478	172.9745163
24	2047	220.2542977	158.157133	0	1.573367658	158.1762989
25	2048	222.9385351	142.563194	0	0.314274227	146.5488304
26	2049	225.6296397	131.673952	0	0.105106688	138.5340365
27	2050	227.730718	125.862963	0	0	133.6154417
	PV or total					
	EAV					

	Discount Rate = 2.5%	**Discount Rate 2.5% Ramsey**				
	year			**rule emission reductions (metric t**		
		HFC-32	**HFC-134a**	**HFC-236fa**	**HFC-245fa**	**HFC-125**
1	2024	0	0	0	0	0
2	2025	0	0	0	0	0
3	2026	240.1107597	805.097484	0.1331252	15.5634091	661.2722983
4	2027	278.0603676	876.610797	0.0444342	15.5634091	758.6660836
5	2028	284.7788545	861.519472	0	15.5634091	743.686471
6	2029	290.7627802	836.57823	0	15.5634091	729.0145163
7	2030	294.7920325	803.247332	0	15.5634091	712.937765
8	2031	296.9736474	769.839993	0	15.5634091	696.0162247
9	2032	297.1595897	735.215278	0	15.5634091	676.4403095
10	2033	295.3782679	700.388437	0	15.5634091	656.4095867
11	2034	293.105388	668.753438	0	15.5634091	633.0027206
12	2035	283.1540655	624.825681	0	15.5634091	589.3674206

13	2036	274.0682173	581.294032	0	15.5634091	547.4758684
14	2037	264.993155	537.018676	0	15.5634091	504.8933716
15	2038	255.9787743	491.969526	0	15.5634091	461.4393431
16	2039	247.0951909	446.093069	0	15.5634091	417.0620427
17	2040	238.4428474	399.322123	0	15.5634091	371.7855933
18	2041	234.6111073	357.202557	0	15.5634091	331.6646583
19	2042	223.3780446	304.378272	0	15.5634091	281.0766351
20	2043	215.9015784	258.957559	0	14.02410662	238.8866262
21	2044	215.6344772	227.842784	0	10.93010865	212.0260552
22	2045	216.6304716	201.355456	0	7.027883789	190.7827063
23	2046	218.1611885	177.812976	0	3.87193478	172.9745163
24	2047	220.2542977	158.157133	0	1.573367658	158.1762989
25	2048	222.9385351	142.563194	0	0.314274227	146.5488304
26	2049	225.6296397	131.673952	0	0.105106688	138.5340365
27	2050	227.730718	125.862963	0	0	133.6154417
	PV or total					
	EAV					

:on) Updated 2024 EPA SC-HFC Values (:

HFC-143a	HFC-227ea	HFC-23		hfc32	hfc134a	hfc236fa	hfc245fa	hfc125
0	0	0		85027	174792	2882149	108262	503902
0.00	0.00	0.00		87991	180182	2925662	111907	516891
389.78	0.00	0.00		90955	185572	2969175	115551	529880
445.82	0.00	0.00		93919	190962	3012688	119196	542868
427.05	0.00	0.00		96883	196351	3056202	122841	555857
410.36	0.00	0.00		99848	201741	3099715	126486	568846
395.55	0.00	0.00		102812	207131	3143228	130131	581835
383.14	0.00	0.00		106308	213062	3186505	134305	595642
371.39	0.00	0.00		109804	218992	3229782	138480	609449
362.78	0.00	0.00		113300	224923	3273059	142655	623256
348.02	0.00	0.00		116796	230853	3316336	146830	637063
325.41	0.00	0.00		120292	236784	3359613	151004	650870
304.46	0.00	0.00		123789	242714	3402890	155179	664677
283.16	0.00	0.00		127285	248645	3446167	159354	678484
261.30	0.00	0.00		130781	254575	3489443	163529	692291
238.84	0.00	0.00		134277	260506	3532720	167704	706098
215.83	0.00	0.00		137773	266436	3575997	171878	719905
197.35	0.00	0.00		141547	272824	3624794	176353	735112
169.23	0.00	0.00		145320	279213	3673590	180827	750318
141.98	0.00	0.00		149094	285601	3722387	185302	765525
115.63	0.00	0.00		152867	291989	3771183	189776	780732
93.09	0.00	0.00		156641	298378	3819980	194251	795939
73.63	0.00	0.00		160414	304766	3868776	198725	811146
56.72	0.00	0.00		164188	311155	3917572	203200	826353
42.51	0.00	0.00		167961	317543	3966369	207674	841560
31.37	0.00	0.00		171735	323931	4015165	212149	856766
26.30	0.00	0.00		175508	330320	4063962	216623	871973

:on) Updated 2024 EPA SC-HFC Values (:

HFC-143a	HFC-227ea	HFC-23		hfc32	hfc134a	hfc236fa	hfc245fa	hfc125
0	0	0		62409	128027	1725397	79585	359179

0	0	0		65018	132666	1758319	82770	369994
389.7848734	0	0		67627	137304	1791241	85956	380810
445.8188397	0	0		70236	141942	1824163	89141	391626
427.0488012	0	0		72845	146581	1857085	92326	402442
410.3571592	0	0		75454	151220	1890007	95511	413258
395.5478206	0	0		78063	155858	1922929	98696	424074
383.1353763	0	0		81168	161004	1956457	102375	435672
371.3909196	0	0		84272	166149	1989986	106054	447269
362.7797544	0	0		87377	171295	2023514	109733	458867
348.0171106	0	0		90481	176440	2057042	113411	470464
325.4055809	0	0		93586	181586	2090570	117090	482062
304.4639116	0	0		96690	186732	2124098	120769	493660
283.158046	0	0		99795	191877	2157626	124447	505257
261.2972125	0	0		102899	197023	2191154	128126	516855
238.8391343	0	0		106004	202168	2224682	131805	528452
215.8319095	0	0		109108	207314	2258210	135484	540050
197.3539776	0	0		112471	212879	2296519	139441	552900
169.234622	0	0		115833	218445	2334827	143398	565749
141.984463	0	0		119195	224010	2373136	147355	578599
115.6294719	0	0		122558	229576	2411444	151312	591449
93.08680655	0	0		125920	235141	2449753	155269	604299
73.62530544	0	0		129282	240707	2488061	159226	617149
56.72106484	0	0		132644	246272	2526370	163183	629998
42.51177396	0	0		136007	251838	2564678	167140	642848
31.37367672	0	0		139369	257403	2602987	171097	655698
26.29799048	0	0		142731	262969	2641295	175054	668548

:on) **Updated 2024 EPA SC-HFC Values (2**

HFC-143a	HFC-227ea	HFC-23		hfc32	hfc134a	hfc236fa	hfc245fa	hfc125
0	0	0		48914	99229	1080961	62270	268797
0	0	0		51240	103268	1105605	65089	277896
389.7848734	0	0		53566	107307	1130249	67907	286996
445.8188397	0	0		55893	111346	1154893	70726	296096
427.0488012	0	0		58219	115385	1179536	73544	305196
410.3571592	0	0		60545	119424	1204180	76363	314296
395.5478206	0	0		62871	123463	1228824	79181	323396
383.1353763	0	0		65661	127978	1254451	82461	333234
371.3909196	0	0		68451	132493	1280077	85741	343072
362.7797544	0	0		71241	137009	1305704	89022	352910
348.0171106	0	0		74031	141524	1331330	92302	362747
325.4055809	0	0		76821	146040	1356957	95582	372585

304.4639116	0	0		79611	150555	1382583	98862	382423
283.158046	0	0		82401	155070	1408210	102142	392261
261.2972125	0	0		85191	159586	1433836	105422	402098
238.8391343	0	0		87981	164101	1459463	108702	411936
215.8319095	0	0		90771	168616	1485089	111983	421774
197.3539776	0	0		93798	173506	1514626	115516	432695
169.234622	0	0		96824	178396	1544163	119049	443616
141.984463	0	0		99851	183286	1573700	122583	454536
115.6294719	0	0		102877	188176	1603238	126116	465457
93.08680655	0	0		105904	193066	1632775	129650	476378
73.62530544	0	0		108930	197956	1662312	133183	487299
56.72106484	0	0		111957	202846	1691849	136716	498219
42.51177396	0	0		114983	207736	1721386	140250	509140
31.37367672	0	0		118010	212625	1750923	143783	520061
26.29799048	0	0		121036	217515	1780460	147317	530982

2020$) **GLOBAL (2022) Total $ benefits (millions)**

hfc143a	hfc227ea	hfc23		hfc32	hfc134a	hfc236fa	hfc245fa	hfc125	hfc143a
899919	582565	4444348		0	0	0	0	0	0
920056	596313	4512450		0	0	0	0	0	0
940192	610062	4580553		24.44885	167.2558	0.442503	2.013255	392.2637	410.2625
960328	623810	4648655		29.23566	187.4019	0.149862	2.076762	461.0683	479.2899
980465	637559	4716757		30.88699	189.3732	0	2.140269	462.7786	468.7377
1000601	651307	4784860		32.50113	188.9387	0	2.203776	464.2492	459.6669
1020738	665055	4852962		33.92969	186.2579	0	2.267283	464.3781	451.995
1041831	679534	4920863		35.34306	183.6229	0	2.340007	464.1143	446.8583
1062925	694013	4988763		36.5282	180.2449	0	2.412749	461.5164	441.9307
1084019	708492	5056664		37.46526	176.3572	0	2.48549	457.996	440.2509
1105112	722971	5124565		38.32411	172.8311	0	2.558231	451.4486	430.5536
1126206	737449	5192466		38.13115	165.6272	0	2.630955	429.4382	410.2637
1147300	751928	5260366		37.98053	157.9469	0	2.703697	407.3765	391.0508
1168394	766407	5328267		37.76002	149.4822	0	2.776438	383.4949	370.3723
1189487	780886	5396168		37.47735	140.2085	0	2.84918	357.6215	347.9484
1210581	795365	5464068		37.14379	130.0959	0	2.921921	329.675	323.6828
1231675	809843	5531969		36.77636	119.1068	0	2.994645	299.6319	297.5994
1255258	825949	5608539		37.17659	109.0982	0	3.072613	272.9437	277.3315
1278842	842055	5685109		36.34011	95.14141	0	3.150564	236.097	242.2849
1302426	858161	5761679		36.03598	82.79586	0	2.909214	204.7253	207.0209
1326010	874267	5838249		36.9022	74.47698	0	2.322128	185.3154	171.6468
1349594	890373	5914819		37.9879	67.25902	0	1.528298	169.9962	140.6409
1373177	906479	5991389		39.1778	60.66669	0	0.861392	157.073	113.1811
1396761	922585	6067959		40.48425	55.09166	0	0.35791	146.328	88.69248
1420345	938691	6144528		41.91929	50.67926	0	0.073065	138.0663	67.59637
1443929	954797	6221098		43.37857	47.74992	0	0.024963	132.8737	50.71443
1467513	970903	6297668		44.74442	46.54287	0	0	130.4308	43.20409

2020$) **GLOBAL (2022) Total $ benefits (millions)**

hfc143a	hfc227ea	hfc23		hfc32	hfc134a	hfc236fa	hfc245fa	hfc125	hfc143a
616846	405943	2672621		0	0	0	0	0	0

633091	417173	2724189		0	0	0	0	0	0
649336	428403	2775758		18.17825	123.7519	0.266953	1.497619	281.909	283.3445
665581	439633	2827326		21.86347	139.2958	0.090741	1.553111	332.6155	332.1847
681826	450863	2878895		23.22351	141.3719	0	1.608604	335.053	325.9653
698070	462093	2930463		24.56074	141.6238	0	1.664096	337.27	320.687
714315	473323	2982032		25.7621	140.1518	0	1.719589	338.4649	316.3072
731508	485263	3034644		26.98504	138.7578	0	1.783688	339.4684	313.7557
748701	497202	3087257		28.03454	136.7516	0	1.847788	338.7026	311.2863
765894	509141	3139869		28.89322	134.3086	0	1.911887	337.1957	311.0513
783086	521081	3192481		29.68941	132.0941	0	1.975969	333.3898	305.0917
800279	533020	3245093		29.66566	127.0169	0	2.040069	318.0602	291.5323
817472	544959	3297706		29.66611	121.5164	0	2.104168	302.5612	278.6307
834665	556898	3350318		29.60491	115.354	0	2.168251	285.583	264.5827
851857	568838	3402930		29.48733	108.5114	0	2.23235	266.9953	249.1849
869050	580777	3455542		29.3229	100.9621	0	2.29645	246.7326	232.3649
886243	592716	3508155		29.12468	92.67707	0	2.360549	224.7744	214.1356
905616	606092	3568270		29.53993	85.12707	0	2.429492	205.2892	200.083
924989	619467	3628386		28.9663	74.43481	0	2.498435	178.02	175.2452
944362	632842	3688501		28.8094	64.9406	0	2.313451	154.7355	150.1065
963735	646217	3748617		29.58559	58.55744	0	1.851476	140.387	124.7517
983108	659592	3808732		30.53758	53.00442	0	1.221602	129.0658	102.4495
1002481	672968	3868848		31.57445	47.91511	0	0.69018	119.5068	82.6273
1021854	686343	3928963		32.70637	43.60378	0	0.287426	111.558	64.88638
1041226	699718	3989079		33.94429	40.19287	0	0.058804	105.4656	49.55352
1060599	713093	4049194		35.20324	37.94318	0	0.020132	101.6906	37.25091
1079972	726468	4109310		36.38817	37.05295	0	0	100.0022	31.79475

2020$)						**GLOBAL (2022) Total $ benefits (millions)**			
hfc143a	**hfc227ea**	**hfc23**		**hfc32**	**hfc134a**	**hfc236fa**	**hfc245fa**	**hfc125**	**hfc143a**
442666	296353	1682108		0	0	0	0	0	0
455887	305613	1720793		0	0	0	0	0	0
469108	314874	1759478		14.39863	96.71567	0.168444	1.183149	212.4597	204.7001
482329	324134	1798163		17.3987	109.2702	0.057449	1.232265	251.48	240.7255
495550	333394	1836848		18.56063	111.2845	0	1.281363	254.0909	236.911
508771	342655	1875532		19.70777	111.8455	0	1.330479	256.5047	233.7247
521992	351915	1914217		20.74849	111.0213	0	1.379577	258.111	231.1443
536119	361848	1954494		21.8296	110.2951	0	1.436725	259.6504	229.9502
550246	371780	1994771		22.77141	109.0505	0	1.493873	259.7976	228.775
564373	381713	2035048		23.55748	107.4257	0	1.551038	259.3338	229.2079
578500	391646	2075324		24.29169	105.9538	0	1.608186	257.0572	225.3846
592626	401578	2115601		24.35135	102.153	0	1.665333	245.8283	215.8868

606753	411511	2155878		24.42598	97.97412		0	1.722481	234.3847	206.8083
620880	421444	2196155		24.44485	93.22609		0	1.779629	221.715	196.8144
635007	431376	2236431		24.41282	87.8928		0	1.836776	207.7145	185.752
649134	441309	2276708		24.33736	81.95152		0	1.893924	192.3316	173.5642
663260	451242	2316985		24.22991	75.37763		0	1.951089	175.5467	160.258
679226	462397	2363401		24.63556	69.38241		0	2.012645	160.6576	150.0654
695192	473552	2409816		24.21273	60.78817		0	2.074201	139.5893	131.7086
711158	484708	2456232		24.13396	53.1347		0	1.924535	121.5571	113.0387
727124	495863	2502647		24.83458	47.99763		0	1.543174	110.4814	94.12334
743090	507018	2549063		25.68338	43.52006		0	1.02004	101.7445	77.43724
759055	518173	2595479		26.6039	39.4051		0	0.577294	94.36218	62.56345
775021	529329	2641894		27.60552	35.91497		0	0.240807	88.22304	49.21281
790987	540484	2688310		28.69717	33.15427		0	0.049344	83.5295	37.64427
806953	551639	2734725		29.80817	31.34256		0	0.016918	80.65496	28.34223
822919	562795	2781141		30.8572	30.64838		0	0	79.42491	24.22702

GLOBAL Discounted millions of dollars of benefits at Discour

hfc227ea	hfc23	Total		hfc32	hfc134a	hfc236fa	hfc245fa	hfc125	hfc143a
0	0	0		0	0	0	0	0	0
0	0	0		0	0	0	0	0	0
0	0	996.6867		23.38085	159.9495781	0.423173	1.92531	375.128481	392.341017
0	0	1159.222		27.54538	176.5671507	0.141198	1.956692	434.411237	451.579427
0	0	1153.917		28.67117	175.7876305	0	1.986727	429.579014	435.110636
0	0	1147.56		29.72366	172.7924581	0	2.015446	424.575509	420.384797
0	0	1138.828		30.57156	167.8233578	0	2.042883	418.417148	407.259563
0	0	1132.279		31.37443	163.0040663	0	2.077251	411.99946	396.681092
0	0	1122.633		31.94728	157.6408256	0	2.110171	403.638679	386.509195
0	0	1114.555		32.28259	151.9612022	0	2.141665	394.640151	379.349768
0	0	1095.716		32.53461	146.7220525	0	2.171768	383.249681	365.511239
0	0	1046.091		31.89241	138.5284659	0	2.200498	359.17672	343.139437
0	0	997.0583		31.29698	130.1524808	0	2.227919	335.689217	322.236384
0	0	943.8859		30.65544	121.3570012	0	2.254049	311.340054	300.686508
0	0	886.1049		29.97632	112.1459588	0	2.278921	286.044091	278.307013
0	0	823.5194		29.27046	102.5195847	0	2.302564	259.794097	255.072109
0	0	756.1091		28.55262	92.47276976	0	2.324998	232.629794	231.051807
0	0	699.6225		28.4368	83.45044916	0	2.350277	208.777771	212.134072
0	0	613.014		27.38618	71.6992789	0	2.374289	177.924444	182.58774
0	0	533.4873		26.75565	61.47347721	0	2.160005	152.002482	153.706893
0	0	470.6635		26.99388	54.47976065	0	1.698632	135.557838	125.559264
0	0	417.4123		27.37741	48.47274094	0	1.101426	122.514127	101.358144
0	0	370.96		27.81769	43.07559674	0	0.61162	111.527635	80.3627827
0	0	330.9543		28.32051	38.53903722	0	0.250374	102.362836	62.0442829
0	0	298.3343		28.89102	34.9284418	0	0.050357	95.156113	46.5878133
0	0	274.7416		29.45494	32.42317883	0	0.01695	90.2239677	34.4361401
0	0	264.9221		29.93338	31.13651394	0	0	87.2563127	28.9029178
				$731.04	**$2,669.10**	**$0.56**	**$42.63**	**$6,743.62**	**$6,392.90**
				$35.28	$128.82	$0.03	$2.06	$325.47	$308.54
				$731.04	$2,669.10	$0.56	$42.63	$6,743.62	$6,392.90

GLOBAL Discounted millions of dollars of benefits at Discour

hfc227ea	hfc23	Total		hfc32	hfc134a	hfc236fa	hfc245fa	hfc125	hfc143a
0	0	0		0	0	0	0	0	0

0	0	0	0	0	0	0	0	0
0	0	708.9483	17.12977	116.6142038	0.251556	1.411239	265.649172	267.001841
0	0	827.6034	20.19847	128.6877941	0.08383	1.434835	307.285316	306.887327
0	0	827.2223	21.03425	128.0448829	0	1.456962	303.467809	295.236817
0	0	825.8056	21.80923	125.7578402	0	1.47767	299.486136	284.760841
0	0	822.4055	22.42746	122.0105814	0	1.497005	294.654021	275.36445
0	0	820.7506	23.03147	118.4284564	0	1.522361	289.732989	267.78748
0	0	816.6229	23.45804	114.42766	0	1.546146	283.41122	260.470448
0	0	813.3608	23.70251	110.1798671	0	1.568414	276.617933	255.170403
0	0	802.2409	23.87809	106.2383937	0	1.589199	268.133077	245.373962
0	0	768.3152	23.39117	100.1519662	0	1.60858	250.788299	229.871254
0	0	734.4786	22.93286	93.9361352	0	1.626591	233.889645	215.390619
0	0	697.2928	22.43682	87.42390718	0	1.643263	216.436206	200.520608
0	0	656.4114	21.90952	80.6255817	0	1.658669	198.381456	185.148077
0	0	611.6789	21.36014	73.54538916	0	1.672839	179.731323	169.265252
0	0	563.0723	20.79976	66.18649612	0	1.685816	160.525457	152.927595
0	0	522.4687	20.68266	59.60251652	0	1.701032	143.735155	140.090017
0	0	459.1648	19.88336	51.09434084	0	1.715003	122.198419	120.293685
0	0	400.9054	19.3879	43.70316315	0	1.556887	104.132522	101.017403
0	0	355.1332	19.51985	38.63478192	0	1.221559	92.6239368	82.3081565
0	0	316.2789	19.7529	34.28532661	0	0.79018	83.4847998	66.2683094
0	0	282.3138	20.02313	30.38564985	0	0.437682	75.7859173	52.398592
0	0	253.042	20.33425	27.10940626	0	0.178699	69.3580327	40.3412555
0	0	229.2151	20.69009	24.49879322	0	0.035843	64.2845588	30.2044023
0	0	212.108	21.03673	22.67406132	0	0.012031	60.7681745	22.2603748
0	0	205.2381	21.31845	21.70791815	0	0	58.5874932	18.6273352
			$532.13	**$1,925.96**	**$0.34**	**$31.05**	**$4,703.15**	**$4,284.99**
			$27.26	$98.65	$0.02	$1.59	$240.90	$219.48
			$532.13	$1,925.96	$0.34	$31.05	$4,703.15	$4,284.99

GLOBAL Discounted millions of dollars of benefits at Discour

hfc227ea	hfc23	Total	hfc32	hfc134a	hfc236fa	hfc245fa	hfc125	hfc143a
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	529.6257	13.37056	89.81011129	0.156417	1.098672	197.289915	190.084425
0	0	620.1642	15.76236	98.99340938	0.052046	1.116371	227.828503	218.085423
0	0	622.1284	16.4049	98.35930093	0	1.132538	224.579287	209.394837
0	0	623.1132	16.99395	96.44401636	0	1.147268	221.183204	201.540104
0	0	622.4047	17.45498	93.39838524	0	1.16059	217.139841	194.453647
0	0	623.162	17.91657	90.52429949	0	1.179187	213.107166	188.730825
0	0	621.8883	18.23371	87.31984906	0	1.196186	208.027272	183.186597
0	0	621.076	18.40307	83.9208199	0	1.211668	202.59118	179.056844
0	0	614.2954	18.51378	80.75211602	0	1.22567	195.914777	171.775709
0	0	589.8847	18.10659	75.95644296	0	1.238268	182.787046	160.52387

0	0	565.3156		17.71911	71.07242034	0	1.249523	170.027451	150.022989
0	0	537.98		17.30029	65.97864142	0	1.259492	156.913747	139.290908
0	0	507.609		16.85621	60.68695097	0	1.268231	143.419717	128.255387
0	0	474.0786		16.39425	55.20458699	0	1.275795	129.559384	116.917173
0	0	437.3633		15.92377	49.53780394	0	1.282246	115.368423	105.320777
0	0	406.7536		15.79548	44.48563433	0	1.290439	103.008201	96.2168017
0	0	358.3731		15.14574	38.02468505	0	1.29747	87.3170014	82.3874094
0	0	313.789		14.72825	32.42656057	0	1.174488	74.1827832	68.9842462
0	0	278.9801		14.78617	28.57713239	0	0.918785	65.7791011	56.0397458
0	0	249.4052		14.91857	25.27926654	0	0.592505	59.0997946	44.9805558
0	0	223.5119		15.07636	22.33076107	0	0.327151	53.4747852	35.4545321
0	0	201.1971		15.26241	19.85650317	0	0.133136	48.7763428	27.2085491
0	0	183.0746		15.47898	17.88310204	0	0.026616	45.0550264	20.3049651
0	0	170.1648		15.68609	16.49354482	0	0.008903	42.4434407	14.9146637
0	0	165.1575		15.84208	15.734868	0	0	40.7767298	12.4381444
				$408.07	**$1,459.05**	**$0.21**	**$23.81**	**$3,425.65**	**$2,995.57**
				$22.15	$79.19	$0.01	$1.29	$185.93	$162.59
				$408.07	$1,459.05	$0.21	$23.81	$3,425.65	$2,995.57

ıt Rate

hfc227ea	hfc23	Total
0	0	0
0	0	0
0	0	953.148415
0	0	1092.20108
0	0	1071.13518
0	0	1049.49187
0	0	1026.11451
0	0	1005.1363
0	0	981.846148
0	0	960.375374
0	0	930.189351
0	0	874.937532
0	0	821.602985
0	0	766.293056
0	0	708.752301
0	0	648.958816
0	0	587.031992
0	0	535.149374
0	0	461.971926
0	0	396.098503
0	0	344.289378
0	0	300.823848
0	0	263.395327
0	0	231.517042
0	0	205.613743
0	0	186.555179
0	0	177.22912
$0.00	**$0.00**	$16,579.86
$0.00	$0.00	$800.20
$0.00	$0.00	$16,579.86

ıt Rate

hfc227ea	hfc23	Total
0	0	0

0	0	0
0	0	668.057782
0	0	764.577572
0	0	749.240716
0	0	733.291718
0	0	715.953518
0	0	700.502758
0	0	683.313519
0	0	667.239123
0	0	645.212723
0	0	605.811269
0	0	567.775855
0	0	528.460806
0	0	487.723302
0	0	445.574944
0	0	402.125122
0	0	365.811378
0	0	315.18481
0	0	269.797873
0	0	234.308289
0	0	204.581512
0	0	179.030968
0	0	157.321644
0	0	139.713689
0	0	126.751368
0	0	120.241195
$0.00	**$0.00**	$11,477.60
$0.00	$0.00	$587.89
$0.00	$0.00	$11,477.60

nt Rate

hfc227ea	hfc23	Total
0	0	0
0	0	0
0	0	491.810098
0	0	561.838117
0	0	549.870859
0	0	537.308538
0	0	523.607444
0	0	511.458044
0	0	497.963615
0	0	485.183579
0	0	468.182057
0	0	438.612218

0	0	410.091489
0	0	380.743076
0	0	350.486498
0	0	319.351193
0	0	287.433025
0	0	260.796559
0	0	224.172302
0	0	191.496331
0	0	166.100932
0	0	144.870692
0	0	126.663586
0	0	111.236944
0	0	98.748693
0	0	89.5466446
0	0	84.7918192
$0.00	**$0.00**	$8,312.36
$0.00	$0.00	$451.16
$0.00	$0.00	$8,312.36

discount.rate	emissions.	gas	mean
2.5% Ramsey	2020	hfc32	39,609
2.5% Ramsey	2021	hfc32	41,935
2.5% Ramsey	2022	hfc32	44,261
2.5% Ramsey	2023	hfc32	46,587
2.5% Ramsey	2024	hfc32	48,914
2.5% Ramsey	2025	hfc32	51,240
2.5% Ramsey	2026	hfc32	53,566
2.5% Ramsey	2027	hfc32	55,893
2.5% Ramsey	2028	hfc32	58,219
2.5% Ramsey	2029	hfc32	60,545
2.5% Ramsey	2030	hfc32	62,871
2.5% Ramsey	2031	hfc32	65,661
2.5% Ramsey	2032	hfc32	68,451
2.5% Ramsey	2033	hfc32	71,241
2.5% Ramsey	2034	hfc32	74,031
2.5% Ramsey	2035	hfc32	76,821
2.5% Ramsey	2036	hfc32	79,611
2.5% Ramsey	2037	hfc32	82,401
2.5% Ramsey	2038	hfc32	85,191
2.5% Ramsey	2039	hfc32	87,981
2.5% Ramsey	2040	hfc32	90,771
2.5% Ramsey	2041	hfc32	93,798
2.5% Ramsey	2042	hfc32	96,824
2.5% Ramsey	2043	hfc32	99,851
2.5% Ramsey	2044	hfc32	102,877
2.5% Ramsey	2045	hfc32	105,904
2.5% Ramsey	2046	hfc32	108,930
2.5% Ramsey	2047	hfc32	111,957
2.5% Ramsey	2048	hfc32	114,983
2.5% Ramsey	2049	hfc32	118,010
2.5% Ramsey	2050	hfc32	121,036
2.5% Ramsey	2020	hfc125	232,397
2.5% Ramsey	2021	hfc125	241,497
2.5% Ramsey	2022	hfc125	250,597
2.5% Ramsey	2023	hfc125	259,697
2.5% Ramsey	2024	hfc125	268,797
2.5% Ramsey	2025	hfc125	277,896
2.5% Ramsey	2026	hfc125	286,996
2.5% Ramsey	2027	hfc125	296,096
2.5% Ramsey	2028	hfc125	305,196
2.5% Ramsey	2029	hfc125	314,296
2.5% Ramsey	2030	hfc125	323,396
2.5% Ramsey	2031	hfc125	333,234
2.5% Ramsey	2032	hfc125	343,072
2.5% Ramsey	2033	hfc125	352,910
2.5% Ramsey	2034	hfc125	362,747

2.5% Ramsey	2035	hfc125	372,585
2.5% Ramsey	2036	hfc125	382,423
2.5% Ramsey	2037	hfc125	392,261
2.5% Ramsey	2038	hfc125	402,098
2.5% Ramsey	2039	hfc125	411,936
2.5% Ramsey	2040	hfc125	421,774
2.5% Ramsey	2041	hfc125	432,695
2.5% Ramsey	2042	hfc125	443,616
2.5% Ramsey	2043	hfc125	454,536
2.5% Ramsey	2044	hfc125	465,457
2.5% Ramsey	2045	hfc125	476,378
2.5% Ramsey	2046	hfc125	487,299
2.5% Ramsey	2047	hfc125	498,219
2.5% Ramsey	2048	hfc125	509,140
2.5% Ramsey	2049	hfc125	520,061
2.5% Ramsey	2050	hfc125	530,982
2.5% Ramsey	2020	hfc143a	389,782
2.5% Ramsey	2021	hfc143a	403,003
2.5% Ramsey	2022	hfc143a	416,224
2.5% Ramsey	2023	hfc143a	429,445
2.5% Ramsey	2024	hfc143a	442,666
2.5% Ramsey	2025	hfc143a	455,887
2.5% Ramsey	2026	hfc143a	469,108
2.5% Ramsey	2027	hfc143a	482,329
2.5% Ramsey	2028	hfc143a	495,550
2.5% Ramsey	2029	hfc143a	508,771
2.5% Ramsey	2030	hfc143a	521,992
2.5% Ramsey	2031	hfc143a	536,119
2.5% Ramsey	2032	hfc143a	550,246
2.5% Ramsey	2033	hfc143a	564,373
2.5% Ramsey	2034	hfc143a	578,500
2.5% Ramsey	2035	hfc143a	592,626
2.5% Ramsey	2036	hfc143a	606,753
2.5% Ramsey	2037	hfc143a	620,880
2.5% Ramsey	2038	hfc143a	635,007
2.5% Ramsey	2039	hfc143a	649,134
2.5% Ramsey	2040	hfc143a	663,260
2.5% Ramsey	2041	hfc143a	679,226
2.5% Ramsey	2042	hfc143a	695,192
2.5% Ramsey	2043	hfc143a	711,158
2.5% Ramsey	2044	hfc143a	727,124
2.5% Ramsey	2045	hfc143a	743,090
2.5% Ramsey	2046	hfc143a	759,055
2.5% Ramsey	2047	hfc143a	775,021
2.5% Ramsey	2048	hfc143a	790,987
2.5% Ramsey	2049	hfc143a	806,953
2.5% Ramsey	2050	hfc143a	822,919

2.5% Ramsey	2020	hfc152a	13,400
2.5% Ramsey	2021	hfc152a	13,977
2.5% Ramsey	2022	hfc152a	14,555
2.5% Ramsey	2023	hfc152a	15,133
2.5% Ramsey	2024	hfc152a	15,710
2.5% Ramsey	2025	hfc152a	16,288
2.5% Ramsey	2026	hfc152a	16,866
2.5% Ramsey	2027	hfc152a	17,444
2.5% Ramsey	2028	hfc152a	18,022
2.5% Ramsey	2029	hfc152a	18,599
2.5% Ramsey	2030	hfc152a	19,177
2.5% Ramsey	2031	hfc152a	19,936
2.5% Ramsey	2032	hfc152a	20,696
2.5% Ramsey	2033	hfc152a	21,455
2.5% Ramsey	2034	hfc152a	22,214
2.5% Ramsey	2035	hfc152a	22,973
2.5% Ramsey	2036	hfc152a	23,732
2.5% Ramsey	2037	hfc152a	24,492
2.5% Ramsey	2038	hfc152a	25,251
2.5% Ramsey	2039	hfc152a	26,010
2.5% Ramsey	2040	hfc152a	26,770
2.5% Ramsey	2041	hfc152a	27,602
2.5% Ramsey	2042	hfc152a	28,434
2.5% Ramsey	2043	hfc152a	29,266
2.5% Ramsey	2044	hfc152a	30,098
2.5% Ramsey	2045	hfc152a	30,930
2.5% Ramsey	2046	hfc152a	31,762
2.5% Ramsey	2047	hfc152a	32,594
2.5% Ramsey	2048	hfc152a	33,426
2.5% Ramsey	2049	hfc152a	34,258
2.5% Ramsey	2050	hfc152a	35,090
2.5% Ramsey	2020	hfc245fa	50,997
2.5% Ramsey	2021	hfc245fa	53,815
2.5% Ramsey	2022	hfc245fa	56,634
2.5% Ramsey	2023	hfc245fa	59,452
2.5% Ramsey	2024	hfc245fa	62,270
2.5% Ramsey	2025	hfc245fa	65,089
2.5% Ramsey	2026	hfc245fa	67,907
2.5% Ramsey	2027	hfc245fa	70,726
2.5% Ramsey	2028	hfc245fa	73,544
2.5% Ramsey	2029	hfc245fa	76,363
2.5% Ramsey	2030	hfc245fa	79,181
2.5% Ramsey	2031	hfc245fa	82,461
2.5% Ramsey	2032	hfc245fa	85,741
2.5% Ramsey	2033	hfc245fa	89,022
2.5% Ramsey	2034	hfc245fa	92,302
2.5% Ramsey	2035	hfc245fa	95,582

2.5% Ramsey	2036	hfc245fa	98,862
2.5% Ramsey	2037	hfc245fa	102,142
2.5% Ramsey	2038	hfc245fa	105,422
2.5% Ramsey	2039	hfc245fa	108,702
2.5% Ramsey	2040	hfc245fa	111,983
2.5% Ramsey	2041	hfc245fa	115,516
2.5% Ramsey	2042	hfc245fa	119,049
2.5% Ramsey	2043	hfc245fa	122,583
2.5% Ramsey	2044	hfc245fa	126,116
2.5% Ramsey	2045	hfc245fa	129,650
2.5% Ramsey	2046	hfc245fa	133,183
2.5% Ramsey	2047	hfc245fa	136,716
2.5% Ramsey	2048	hfc245fa	140,250
2.5% Ramsey	2049	hfc245fa	143,783
2.5% Ramsey	2050	hfc245fa	147,317
2.5% Ramsey	2020	hfc43_10	136,624
2.5% Ramsey	2021	hfc43_10	141,686
2.5% Ramsey	2022	hfc43_10	146,748
2.5% Ramsey	2023	hfc43_10	151,810
2.5% Ramsey	2024	hfc43_10	156,872
2.5% Ramsey	2025	hfc43_10	161,935
2.5% Ramsey	2026	hfc43_10	166,997
2.5% Ramsey	2027	hfc43_10	172,059
2.5% Ramsey	2028	hfc43_10	177,122
2.5% Ramsey	2029	hfc43_10	182,184
2.5% Ramsey	2030	hfc43_10	187,246
2.5% Ramsey	2031	hfc43_10	192,774
2.5% Ramsey	2032	hfc43_10	198,302
2.5% Ramsey	2033	hfc43_10	203,830
2.5% Ramsey	2034	hfc43_10	209,358
2.5% Ramsey	2035	hfc43_10	214,886
2.5% Ramsey	2036	hfc43_10	220,414
2.5% Ramsey	2037	hfc43_10	225,942
2.5% Ramsey	2038	hfc43_10	231,470
2.5% Ramsey	2039	hfc43_10	236,998
2.5% Ramsey	2040	hfc43_10	242,526
2.5% Ramsey	2041	hfc43_10	248,496
2.5% Ramsey	2042	hfc43_10	254,466
2.5% Ramsey	2043	hfc43_10	260,437
2.5% Ramsey	2044	hfc43_10	266,408
2.5% Ramsey	2045	hfc43_10	272,378
2.5% Ramsey	2046	hfc43_10	278,348
2.5% Ramsey	2047	hfc43_10	284,319
2.5% Ramsey	2048	hfc43_10	290,290
2.5% Ramsey	2049	hfc43_10	296,260
2.5% Ramsey	2050	hfc43_10	302,230
2.5% Ramsey	2020	hfc23	1,527,369

2.5% Ramsey	2021	hfc23	1,566,054
2.5% Ramsey	2022	hfc23	1,604,739
2.5% Ramsey	2023	hfc23	1,643,424
2.5% Ramsey	2024	hfc23	1,682,108
2.5% Ramsey	2025	hfc23	1,720,793
2.5% Ramsey	2026	hfc23	1,759,478
2.5% Ramsey	2027	hfc23	1,798,163
2.5% Ramsey	2028	hfc23	1,836,848
2.5% Ramsey	2029	hfc23	1,875,532
2.5% Ramsey	2030	hfc23	1,914,217
2.5% Ramsey	2031	hfc23	1,954,494
2.5% Ramsey	2032	hfc23	1,994,771
2.5% Ramsey	2033	hfc23	2,035,048
2.5% Ramsey	2034	hfc23	2,075,324
2.5% Ramsey	2035	hfc23	2,115,601
2.5% Ramsey	2036	hfc23	2,155,878
2.5% Ramsey	2037	hfc23	2,196,155
2.5% Ramsey	2038	hfc23	2,236,431
2.5% Ramsey	2039	hfc23	2,276,708
2.5% Ramsey	2040	hfc23	2,316,985
2.5% Ramsey	2041	hfc23	2,363,401
2.5% Ramsey	2042	hfc23	2,409,816
2.5% Ramsey	2043	hfc23	2,456,232
2.5% Ramsey	2044	hfc23	2,502,647
2.5% Ramsey	2045	hfc23	2,549,063
2.5% Ramsey	2046	hfc23	2,595,479
2.5% Ramsey	2047	hfc23	2,641,894
2.5% Ramsey	2048	hfc23	2,688,310
2.5% Ramsey	2049	hfc23	2,734,725
2.5% Ramsey	2050	hfc23	2,781,141
2.5% Ramsey	2020	hfc134a	83,074
2.5% Ramsey	2021	hfc134a	87,113
2.5% Ramsey	2022	hfc134a	91,152
2.5% Ramsey	2023	hfc134a	95,191
2.5% Ramsey	2024	hfc134a	99,229
2.5% Ramsey	2025	hfc134a	103,268
2.5% Ramsey	2026	hfc134a	107,307
2.5% Ramsey	2027	hfc134a	111,346
2.5% Ramsey	2028	hfc134a	115,385
2.5% Ramsey	2029	hfc134a	119,424
2.5% Ramsey	2030	hfc134a	123,463
2.5% Ramsey	2031	hfc134a	127,978
2.5% Ramsey	2032	hfc134a	132,493
2.5% Ramsey	2033	hfc134a	137,009
2.5% Ramsey	2034	hfc134a	141,524
2.5% Ramsey	2035	hfc134a	146,040
2.5% Ramsey	2036	hfc134a	150,555

2.5% Ramsey	2037	hfc134a	155,070
2.5% Ramsey	2038	hfc134a	159,586
2.5% Ramsey	2039	hfc134a	164,101
2.5% Ramsey	2040	hfc134a	168,616
2.5% Ramsey	2041	hfc134a	173,506
2.5% Ramsey	2042	hfc134a	178,396
2.5% Ramsey	2043	hfc134a	183,286
2.5% Ramsey	2044	hfc134a	188,176
2.5% Ramsey	2045	hfc134a	193,066
2.5% Ramsey	2046	hfc134a	197,956
2.5% Ramsey	2047	hfc134a	202,846
2.5% Ramsey	2048	hfc134a	207,736
2.5% Ramsey	2049	hfc134a	212,625
2.5% Ramsey	2050	hfc134a	217,515
2.5% Ramsey	2020	hfc227ea	259,311
2.5% Ramsey	2021	hfc227ea	268,572
2.5% Ramsey	2022	hfc227ea	277,832
2.5% Ramsey	2023	hfc227ea	287,092
2.5% Ramsey	2024	hfc227ea	296,353
2.5% Ramsey	2025	hfc227ea	305,613
2.5% Ramsey	2026	hfc227ea	314,874
2.5% Ramsey	2027	hfc227ea	324,134
2.5% Ramsey	2028	hfc227ea	333,394
2.5% Ramsey	2029	hfc227ea	342,655
2.5% Ramsey	2030	hfc227ea	351,915
2.5% Ramsey	2031	hfc227ea	361,848
2.5% Ramsey	2032	hfc227ea	371,780
2.5% Ramsey	2033	hfc227ea	381,713
2.5% Ramsey	2034	hfc227ea	391,646
2.5% Ramsey	2035	hfc227ea	401,578
2.5% Ramsey	2036	hfc227ea	411,511
2.5% Ramsey	2037	hfc227ea	421,444
2.5% Ramsey	2038	hfc227ea	431,376
2.5% Ramsey	2039	hfc227ea	441,309
2.5% Ramsey	2040	hfc227ea	451,242
2.5% Ramsey	2041	hfc227ea	462,397
2.5% Ramsey	2042	hfc227ea	473,552
2.5% Ramsey	2043	hfc227ea	484,708
2.5% Ramsey	2044	hfc227ea	495,863
2.5% Ramsey	2045	hfc227ea	507,018
2.5% Ramsey	2046	hfc227ea	518,173
2.5% Ramsey	2047	hfc227ea	529,329
2.5% Ramsey	2048	hfc227ea	540,484
2.5% Ramsey	2049	hfc227ea	551,639
2.5% Ramsey	2050	hfc227ea	562,795
2.5% Ramsey	2020	hfc236fa	982,385
2.5% Ramsey	2021	hfc236fa	1,007,029

2.5% Ramsey	2022	hfc236fa	1,031,673
2.5% Ramsey	2023	hfc236fa	1,056,317
2.5% Ramsey	2024	hfc236fa	1,080,961
2.5% Ramsey	2025	hfc236fa	1,105,605
2.5% Ramsey	2026	hfc236fa	1,130,249
2.5% Ramsey	2027	hfc236fa	1,154,893
2.5% Ramsey	2028	hfc236fa	1,179,536
2.5% Ramsey	2029	hfc236fa	1,204,180
2.5% Ramsey	2030	hfc236fa	1,228,824
2.5% Ramsey	2031	hfc236fa	1,254,451
2.5% Ramsey	2032	hfc236fa	1,280,077
2.5% Ramsey	2033	hfc236fa	1,305,704
2.5% Ramsey	2034	hfc236fa	1,331,330
2.5% Ramsey	2035	hfc236fa	1,356,957
2.5% Ramsey	2036	hfc236fa	1,382,583
2.5% Ramsey	2037	hfc236fa	1,408,210
2.5% Ramsey	2038	hfc236fa	1,433,836
2.5% Ramsey	2039	hfc236fa	1,459,463
2.5% Ramsey	2040	hfc236fa	1,485,089
2.5% Ramsey	2041	hfc236fa	1,514,626
2.5% Ramsey	2042	hfc236fa	1,544,163
2.5% Ramsey	2043	hfc236fa	1,573,700
2.5% Ramsey	2044	hfc236fa	1,603,238
2.5% Ramsey	2045	hfc236fa	1,632,775
2.5% Ramsey	2046	hfc236fa	1,662,312
2.5% Ramsey	2047	hfc236fa	1,691,849
2.5% Ramsey	2048	hfc236fa	1,721,386
2.5% Ramsey	2049	hfc236fa	1,750,923
2.5% Ramsey	2050	hfc236fa	1,780,460
2.0% Ramsey	2020	hfc32	51,973
2.0% Ramsey	2021	hfc32	54,582
2.0% Ramsey	2022	hfc32	57,191
2.0% Ramsey	2023	hfc32	59,800
2.0% Ramsey	2024	hfc32	62,409
2.0% Ramsey	2025	hfc32	65,018
2.0% Ramsey	2026	hfc32	67,627
2.0% Ramsey	2027	hfc32	70,236
2.0% Ramsey	2028	hfc32	72,845
2.0% Ramsey	2029	hfc32	75,454
2.0% Ramsey	2030	hfc32	78,063
2.0% Ramsey	2031	hfc32	81,168
2.0% Ramsey	2032	hfc32	84,272
2.0% Ramsey	2033	hfc32	87,377
2.0% Ramsey	2034	hfc32	90,481
2.0% Ramsey	2035	hfc32	93,586
2.0% Ramsey	2036	hfc32	96,690
2.0% Ramsey	2037	hfc32	99,795

2.0% Ramsey	2038	hfc32	102,899
2.0% Ramsey	2039	hfc32	106,004
2.0% Ramsey	2040	hfc32	109,108
2.0% Ramsey	2041	hfc32	112,471
2.0% Ramsey	2042	hfc32	115,833
2.0% Ramsey	2043	hfc32	119,195
2.0% Ramsey	2044	hfc32	122,558
2.0% Ramsey	2045	hfc32	125,920
2.0% Ramsey	2046	hfc32	129,282
2.0% Ramsey	2047	hfc32	132,644
2.0% Ramsey	2048	hfc32	136,007
2.0% Ramsey	2049	hfc32	139,369
2.0% Ramsey	2050	hfc32	142,731
2.0% Ramsey	2020	hfc125	315,915
2.0% Ramsey	2021	hfc125	326,731
2.0% Ramsey	2022	hfc125	337,547
2.0% Ramsey	2023	hfc125	348,363
2.0% Ramsey	2024	hfc125	359,179
2.0% Ramsey	2025	hfc125	369,994
2.0% Ramsey	2026	hfc125	380,810
2.0% Ramsey	2027	hfc125	391,626
2.0% Ramsey	2028	hfc125	402,442
2.0% Ramsey	2029	hfc125	413,258
2.0% Ramsey	2030	hfc125	424,074
2.0% Ramsey	2031	hfc125	435,672
2.0% Ramsey	2032	hfc125	447,269
2.0% Ramsey	2033	hfc125	458,867
2.0% Ramsey	2034	hfc125	470,464
2.0% Ramsey	2035	hfc125	482,062
2.0% Ramsey	2036	hfc125	493,660
2.0% Ramsey	2037	hfc125	505,257
2.0% Ramsey	2038	hfc125	516,855
2.0% Ramsey	2039	hfc125	528,452
2.0% Ramsey	2040	hfc125	540,050
2.0% Ramsey	2041	hfc125	552,900
2.0% Ramsey	2042	hfc125	565,749
2.0% Ramsey	2043	hfc125	578,599
2.0% Ramsey	2044	hfc125	591,449
2.0% Ramsey	2045	hfc125	604,299
2.0% Ramsey	2046	hfc125	617,149
2.0% Ramsey	2047	hfc125	629,998
2.0% Ramsey	2048	hfc125	642,848
2.0% Ramsey	2049	hfc125	655,698
2.0% Ramsey	2050	hfc125	668,548
2.0% Ramsey	2020	hfc143a	551,867
2.0% Ramsey	2021	hfc143a	568,112
2.0% Ramsey	2022	hfc143a	584,357

2.0% Ramsey	2023	hfc143a	600,602
2.0% Ramsey	2024	hfc143a	616,846
2.0% Ramsey	2025	hfc143a	633,091
2.0% Ramsey	2026	hfc143a	649,336
2.0% Ramsey	2027	hfc143a	665,581
2.0% Ramsey	2028	hfc143a	681,826
2.0% Ramsey	2029	hfc143a	698,070
2.0% Ramsey	2030	hfc143a	714,315
2.0% Ramsey	2031	hfc143a	731,508
2.0% Ramsey	2032	hfc143a	748,701
2.0% Ramsey	2033	hfc143a	765,894
2.0% Ramsey	2034	hfc143a	783,086
2.0% Ramsey	2035	hfc143a	800,279
2.0% Ramsey	2036	hfc143a	817,472
2.0% Ramsey	2037	hfc143a	834,665
2.0% Ramsey	2038	hfc143a	851,857
2.0% Ramsey	2039	hfc143a	869,050
2.0% Ramsey	2040	hfc143a	886,243
2.0% Ramsey	2041	hfc143a	905,616
2.0% Ramsey	2042	hfc143a	924,989
2.0% Ramsey	2043	hfc143a	944,362
2.0% Ramsey	2044	hfc143a	963,735
2.0% Ramsey	2045	hfc143a	983,108
2.0% Ramsey	2046	hfc143a	1,002,481
2.0% Ramsey	2047	hfc143a	1,021,854
2.0% Ramsey	2048	hfc143a	1,041,226
2.0% Ramsey	2049	hfc143a	1,060,599
2.0% Ramsey	2050	hfc143a	1,079,972
2.0% Ramsey	2020	hfc152a	16,287
2.0% Ramsey	2021	hfc152a	16,925
2.0% Ramsey	2022	hfc152a	17,563
2.0% Ramsey	2023	hfc152a	18,201
2.0% Ramsey	2024	hfc152a	18,839
2.0% Ramsey	2025	hfc152a	19,478
2.0% Ramsey	2026	hfc152a	20,116
2.0% Ramsey	2027	hfc152a	20,754
2.0% Ramsey	2028	hfc152a	21,392
2.0% Ramsey	2029	hfc152a	22,030
2.0% Ramsey	2030	hfc152a	22,668
2.0% Ramsey	2031	hfc152a	23,499
2.0% Ramsey	2032	hfc152a	24,329
2.0% Ramsey	2033	hfc152a	25,160
2.0% Ramsey	2034	hfc152a	25,990
2.0% Ramsey	2035	hfc152a	26,821
2.0% Ramsey	2036	hfc152a	27,651
2.0% Ramsey	2037	hfc152a	28,482
2.0% Ramsey	2038	hfc152a	29,312

2.0% Ramsey	2039	hfc152a	30,143
2.0% Ramsey	2040	hfc152a	30,974
2.0% Ramsey	2041	hfc152a	31,889
2.0% Ramsey	2042	hfc152a	32,804
2.0% Ramsey	2043	hfc152a	33,719
2.0% Ramsey	2044	hfc152a	34,635
2.0% Ramsey	2045	hfc152a	35,550
2.0% Ramsey	2046	hfc152a	36,465
2.0% Ramsey	2047	hfc152a	37,381
2.0% Ramsey	2048	hfc152a	38,296
2.0% Ramsey	2049	hfc152a	39,211
2.0% Ramsey	2050	hfc152a	40,126
2.0% Ramsey	2020	hfc245fa	66,844
2.0% Ramsey	2021	hfc245fa	70,030
2.0% Ramsey	2022	hfc245fa	73,215
2.0% Ramsey	2023	hfc245fa	76,400
2.0% Ramsey	2024	hfc245fa	79,585
2.0% Ramsey	2025	hfc245fa	82,770
2.0% Ramsey	2026	hfc245fa	85,956
2.0% Ramsey	2027	hfc245fa	89,141
2.0% Ramsey	2028	hfc245fa	92,326
2.0% Ramsey	2029	hfc245fa	95,511
2.0% Ramsey	2030	hfc245fa	98,696
2.0% Ramsey	2031	hfc245fa	102,375
2.0% Ramsey	2032	hfc245fa	106,054
2.0% Ramsey	2033	hfc245fa	109,733
2.0% Ramsey	2034	hfc245fa	113,411
2.0% Ramsey	2035	hfc245fa	117,090
2.0% Ramsey	2036	hfc245fa	120,769
2.0% Ramsey	2037	hfc245fa	124,447
2.0% Ramsey	2038	hfc245fa	128,126
2.0% Ramsey	2039	hfc245fa	131,805
2.0% Ramsey	2040	hfc245fa	135,484
2.0% Ramsey	2041	hfc245fa	139,441
2.0% Ramsey	2042	hfc245fa	143,398
2.0% Ramsey	2043	hfc245fa	147,355
2.0% Ramsey	2044	hfc245fa	151,312
2.0% Ramsey	2045	hfc245fa	155,269
2.0% Ramsey	2046	hfc245fa	159,226
2.0% Ramsey	2047	hfc245fa	163,183
2.0% Ramsey	2048	hfc245fa	167,140
2.0% Ramsey	2049	hfc245fa	171,097
2.0% Ramsey	2050	hfc245fa	175,054
2.0% Ramsey	2020	hfc43_10	172,539
2.0% Ramsey	2021	hfc43_10	178,375
2.0% Ramsey	2022	hfc43_10	184,211
2.0% Ramsey	2023	hfc43_10	190,047

2.0% Ramsey	2024	hfc43_10	195,884
2.0% Ramsey	2025	hfc43_10	201,720
2.0% Ramsey	2026	hfc43_10	207,556
2.0% Ramsey	2027	hfc43_10	213,392
2.0% Ramsey	2028	hfc43_10	219,228
2.0% Ramsey	2029	hfc43_10	225,064
2.0% Ramsey	2030	hfc43_10	230,900
2.0% Ramsey	2031	hfc43_10	237,257
2.0% Ramsey	2032	hfc43_10	243,614
2.0% Ramsey	2033	hfc43_10	249,970
2.0% Ramsey	2034	hfc43_10	256,327
2.0% Ramsey	2035	hfc43_10	262,684
2.0% Ramsey	2036	hfc43_10	269,040
2.0% Ramsey	2037	hfc43_10	275,397
2.0% Ramsey	2038	hfc43_10	281,754
2.0% Ramsey	2039	hfc43_10	288,110
2.0% Ramsey	2040	hfc43_10	294,467
2.0% Ramsey	2041	hfc43_10	301,358
2.0% Ramsey	2042	hfc43_10	308,249
2.0% Ramsey	2043	hfc43_10	315,140
2.0% Ramsey	2044	hfc43_10	322,031
2.0% Ramsey	2045	hfc43_10	328,922
2.0% Ramsey	2046	hfc43_10	335,813
2.0% Ramsey	2047	hfc43_10	342,704
2.0% Ramsey	2048	hfc43_10	349,595
2.0% Ramsey	2049	hfc43_10	356,486
2.0% Ramsey	2050	hfc43_10	363,377
2.0% Ramsey	2020	hfc23	2,466,347
2.0% Ramsey	2021	hfc23	2,517,915
2.0% Ramsey	2022	hfc23	2,569,484
2.0% Ramsey	2023	hfc23	2,621,052
2.0% Ramsey	2024	hfc23	2,672,621
2.0% Ramsey	2025	hfc23	2,724,189
2.0% Ramsey	2026	hfc23	2,775,758
2.0% Ramsey	2027	hfc23	2,827,326
2.0% Ramsey	2028	hfc23	2,878,895
2.0% Ramsey	2029	hfc23	2,930,463
2.0% Ramsey	2030	hfc23	2,982,032
2.0% Ramsey	2031	hfc23	3,034,644
2.0% Ramsey	2032	hfc23	3,087,257
2.0% Ramsey	2033	hfc23	3,139,869
2.0% Ramsey	2034	hfc23	3,192,481
2.0% Ramsey	2035	hfc23	3,245,093
2.0% Ramsey	2036	hfc23	3,297,706
2.0% Ramsey	2037	hfc23	3,350,318
2.0% Ramsey	2038	hfc23	3,402,930
2.0% Ramsey	2039	hfc23	3,455,542

2.0% Ramsey	2040	hfc23	3,508,155
2.0% Ramsey	2041	hfc23	3,568,270
2.0% Ramsey	2042	hfc23	3,628,386
2.0% Ramsey	2043	hfc23	3,688,501
2.0% Ramsey	2044	hfc23	3,748,617
2.0% Ramsey	2045	hfc23	3,808,732
2.0% Ramsey	2046	hfc23	3,868,848
2.0% Ramsey	2047	hfc23	3,928,963
2.0% Ramsey	2048	hfc23	3,989,079
2.0% Ramsey	2049	hfc23	4,049,194
2.0% Ramsey	2050	hfc23	4,109,310
2.0% Ramsey	2020	hfc134a	109,473
2.0% Ramsey	2021	hfc134a	114,112
2.0% Ramsey	2022	hfc134a	118,750
2.0% Ramsey	2023	hfc134a	123,388
2.0% Ramsey	2024	hfc134a	128,027
2.0% Ramsey	2025	hfc134a	132,666
2.0% Ramsey	2026	hfc134a	137,304
2.0% Ramsey	2027	hfc134a	141,942
2.0% Ramsey	2028	hfc134a	146,581
2.0% Ramsey	2029	hfc134a	151,220
2.0% Ramsey	2030	hfc134a	155,858
2.0% Ramsey	2031	hfc134a	161,004
2.0% Ramsey	2032	hfc134a	166,149
2.0% Ramsey	2033	hfc134a	171,295
2.0% Ramsey	2034	hfc134a	176,440
2.0% Ramsey	2035	hfc134a	181,586
2.0% Ramsey	2036	hfc134a	186,732
2.0% Ramsey	2037	hfc134a	191,877
2.0% Ramsey	2038	hfc134a	197,023
2.0% Ramsey	2039	hfc134a	202,168
2.0% Ramsey	2040	hfc134a	207,314
2.0% Ramsey	2041	hfc134a	212,879
2.0% Ramsey	2042	hfc134a	218,445
2.0% Ramsey	2043	hfc134a	224,010
2.0% Ramsey	2044	hfc134a	229,576
2.0% Ramsey	2045	hfc134a	235,141
2.0% Ramsey	2046	hfc134a	240,707
2.0% Ramsey	2047	hfc134a	246,272
2.0% Ramsey	2048	hfc134a	251,838
2.0% Ramsey	2049	hfc134a	257,403
2.0% Ramsey	2050	hfc134a	262,969
2.0% Ramsey	2020	hfc227ea	361,022
2.0% Ramsey	2021	hfc227ea	372,252
2.0% Ramsey	2022	hfc227ea	383,482
2.0% Ramsey	2023	hfc227ea	394,712
2.0% Ramsey	2024	hfc227ea	405,943

2.0% Ramsey	2025	hfc227ea	417,173
2.0% Ramsey	2026	hfc227ea	428,403
2.0% Ramsey	2027	hfc227ea	439,633
2.0% Ramsey	2028	hfc227ea	450,863
2.0% Ramsey	2029	hfc227ea	462,093
2.0% Ramsey	2030	hfc227ea	473,323
2.0% Ramsey	2031	hfc227ea	485,263
2.0% Ramsey	2032	hfc227ea	497,202
2.0% Ramsey	2033	hfc227ea	509,141
2.0% Ramsey	2034	hfc227ea	521,081
2.0% Ramsey	2035	hfc227ea	533,020
2.0% Ramsey	2036	hfc227ea	544,959
2.0% Ramsey	2037	hfc227ea	556,898
2.0% Ramsey	2038	hfc227ea	568,838
2.0% Ramsey	2039	hfc227ea	580,777
2.0% Ramsey	2040	hfc227ea	592,716
2.0% Ramsey	2041	hfc227ea	606,092
2.0% Ramsey	2042	hfc227ea	619,467
2.0% Ramsey	2043	hfc227ea	632,842
2.0% Ramsey	2044	hfc227ea	646,217
2.0% Ramsey	2045	hfc227ea	659,592
2.0% Ramsey	2046	hfc227ea	672,968
2.0% Ramsey	2047	hfc227ea	686,343
2.0% Ramsey	2048	hfc227ea	699,718
2.0% Ramsey	2049	hfc227ea	713,093
2.0% Ramsey	2050	hfc227ea	726,468
2.0% Ramsey	2020	hfc236fa	1,593,709
2.0% Ramsey	2021	hfc236fa	1,626,631
2.0% Ramsey	2022	hfc236fa	1,659,553
2.0% Ramsey	2023	hfc236fa	1,692,475
2.0% Ramsey	2024	hfc236fa	1,725,397
2.0% Ramsey	2025	hfc236fa	1,758,319
2.0% Ramsey	2026	hfc236fa	1,791,241
2.0% Ramsey	2027	hfc236fa	1,824,163
2.0% Ramsey	2028	hfc236fa	1,857,085
2.0% Ramsey	2029	hfc236fa	1,890,007
2.0% Ramsey	2030	hfc236fa	1,922,929
2.0% Ramsey	2031	hfc236fa	1,956,457
2.0% Ramsey	2032	hfc236fa	1,989,986
2.0% Ramsey	2033	hfc236fa	2,023,514
2.0% Ramsey	2034	hfc236fa	2,057,042
2.0% Ramsey	2035	hfc236fa	2,090,570
2.0% Ramsey	2036	hfc236fa	2,124,098
2.0% Ramsey	2037	hfc236fa	2,157,626
2.0% Ramsey	2038	hfc236fa	2,191,154
2.0% Ramsey	2039	hfc236fa	2,224,682
2.0% Ramsey	2040	hfc236fa	2,258,210

2.0% Ramsey	2041	hfc236fa	2,296,519
2.0% Ramsey	2042	hfc236fa	2,334,827
2.0% Ramsey	2043	hfc236fa	2,373,136
2.0% Ramsey	2044	hfc236fa	2,411,444
2.0% Ramsey	2045	hfc236fa	2,449,753
2.0% Ramsey	2046	hfc236fa	2,488,061
2.0% Ramsey	2047	hfc236fa	2,526,370
2.0% Ramsey	2048	hfc236fa	2,564,678
2.0% Ramsey	2049	hfc236fa	2,602,987
2.0% Ramsey	2050	hfc236fa	2,641,295
1.5% Ramsey	2020	hfc32	73,170
1.5% Ramsey	2021	hfc32	76,134
1.5% Ramsey	2022	hfc32	79,098
1.5% Ramsey	2023	hfc32	82,062
1.5% Ramsey	2024	hfc32	85,027
1.5% Ramsey	2025	hfc32	87,991
1.5% Ramsey	2026	hfc32	90,955
1.5% Ramsey	2027	hfc32	93,919
1.5% Ramsey	2028	hfc32	96,883
1.5% Ramsey	2029	hfc32	99,848
1.5% Ramsey	2030	hfc32	102,812
1.5% Ramsey	2031	hfc32	106,308
1.5% Ramsey	2032	hfc32	109,804
1.5% Ramsey	2033	hfc32	113,300
1.5% Ramsey	2034	hfc32	116,796
1.5% Ramsey	2035	hfc32	120,292
1.5% Ramsey	2036	hfc32	123,789
1.5% Ramsey	2037	hfc32	127,285
1.5% Ramsey	2038	hfc32	130,781
1.5% Ramsey	2039	hfc32	134,277
1.5% Ramsey	2040	hfc32	137,773
1.5% Ramsey	2041	hfc32	141,547
1.5% Ramsey	2042	hfc32	145,320
1.5% Ramsey	2043	hfc32	149,094
1.5% Ramsey	2044	hfc32	152,867
1.5% Ramsey	2045	hfc32	156,641
1.5% Ramsey	2046	hfc32	160,414
1.5% Ramsey	2047	hfc32	164,188
1.5% Ramsey	2048	hfc32	167,961
1.5% Ramsey	2049	hfc32	171,735
1.5% Ramsey	2050	hfc32	175,508
1.5% Ramsey	2020	hfc125	451,947
1.5% Ramsey	2021	hfc125	464,936
1.5% Ramsey	2022	hfc125	477,924
1.5% Ramsey	2023	hfc125	490,913
1.5% Ramsey	2024	hfc125	503,902
1.5% Ramsey	2025	hfc125	516,891

1.5% Ramsey	2026	hfc125	529,880
1.5% Ramsey	2027	hfc125	542,868
1.5% Ramsey	2028	hfc125	555,857
1.5% Ramsey	2029	hfc125	568,846
1.5% Ramsey	2030	hfc125	581,835
1.5% Ramsey	2031	hfc125	595,642
1.5% Ramsey	2032	hfc125	609,449
1.5% Ramsey	2033	hfc125	623,256
1.5% Ramsey	2034	hfc125	637,063
1.5% Ramsey	2035	hfc125	650,870
1.5% Ramsey	2036	hfc125	664,677
1.5% Ramsey	2037	hfc125	678,484
1.5% Ramsey	2038	hfc125	692,291
1.5% Ramsey	2039	hfc125	706,098
1.5% Ramsey	2040	hfc125	719,905
1.5% Ramsey	2041	hfc125	735,112
1.5% Ramsey	2042	hfc125	750,318
1.5% Ramsey	2043	hfc125	765,525
1.5% Ramsey	2044	hfc125	780,732
1.5% Ramsey	2045	hfc125	795,939
1.5% Ramsey	2046	hfc125	811,146
1.5% Ramsey	2047	hfc125	826,353
1.5% Ramsey	2048	hfc125	841,560
1.5% Ramsey	2049	hfc125	856,766
1.5% Ramsey	2050	hfc125	871,973
1.5% Ramsey	2020	hfc143a	819,373
1.5% Ramsey	2021	hfc143a	839,510
1.5% Ramsey	2022	hfc143a	859,646
1.5% Ramsey	2023	hfc143a	879,783
1.5% Ramsey	2024	hfc143a	899,919
1.5% Ramsey	2025	hfc143a	920,056
1.5% Ramsey	2026	hfc143a	940,192
1.5% Ramsey	2027	hfc143a	960,328
1.5% Ramsey	2028	hfc143a	980,465
1.5% Ramsey	2029	hfc143a	1,000,601
1.5% Ramsey	2030	hfc143a	1,020,738
1.5% Ramsey	2031	hfc143a	1,041,831
1.5% Ramsey	2032	hfc143a	1,062,925
1.5% Ramsey	2033	hfc143a	1,084,019
1.5% Ramsey	2034	hfc143a	1,105,112
1.5% Ramsey	2035	hfc143a	1,126,206
1.5% Ramsey	2036	hfc143a	1,147,300
1.5% Ramsey	2037	hfc143a	1,168,394
1.5% Ramsey	2038	hfc143a	1,189,487
1.5% Ramsey	2039	hfc143a	1,210,581
1.5% Ramsey	2040	hfc143a	1,231,675
1.5% Ramsey	2041	hfc143a	1,255,258

1.5% Ramsey	2042	hfc143a	1,278,842
1.5% Ramsey	2043	hfc143a	1,302,426
1.5% Ramsey	2044	hfc143a	1,326,010
1.5% Ramsey	2045	hfc143a	1,349,594
1.5% Ramsey	2046	hfc143a	1,373,177
1.5% Ramsey	2047	hfc143a	1,396,761
1.5% Ramsey	2048	hfc143a	1,420,345
1.5% Ramsey	2049	hfc143a	1,443,929
1.5% Ramsey	2050	hfc143a	1,467,513
1.5% Ramsey	2020	hfc152a	21,395
1.5% Ramsey	2021	hfc152a	22,114
1.5% Ramsey	2022	hfc152a	22,834
1.5% Ramsey	2023	hfc152a	23,553
1.5% Ramsey	2024	hfc152a	24,272
1.5% Ramsey	2025	hfc152a	24,992
1.5% Ramsey	2026	hfc152a	25,711
1.5% Ramsey	2027	hfc152a	26,430
1.5% Ramsey	2028	hfc152a	27,149
1.5% Ramsey	2029	hfc152a	27,869
1.5% Ramsey	2030	hfc152a	28,588
1.5% Ramsey	2031	hfc152a	29,514
1.5% Ramsey	2032	hfc152a	30,439
1.5% Ramsey	2033	hfc152a	31,365
1.5% Ramsey	2034	hfc152a	32,290
1.5% Ramsey	2035	hfc152a	33,216
1.5% Ramsey	2036	hfc152a	34,141
1.5% Ramsey	2037	hfc152a	35,067
1.5% Ramsey	2038	hfc152a	35,992
1.5% Ramsey	2039	hfc152a	36,918
1.5% Ramsey	2040	hfc152a	37,844
1.5% Ramsey	2041	hfc152a	38,871
1.5% Ramsey	2042	hfc152a	39,898
1.5% Ramsey	2043	hfc152a	40,925
1.5% Ramsey	2044	hfc152a	41,952
1.5% Ramsey	2045	hfc152a	42,979
1.5% Ramsey	2046	hfc152a	44,006
1.5% Ramsey	2047	hfc152a	45,033
1.5% Ramsey	2048	hfc152a	46,060
1.5% Ramsey	2049	hfc152a	47,087
1.5% Ramsey	2050	hfc152a	48,114
1.5% Ramsey	2020	hfc245fa	93,683
1.5% Ramsey	2021	hfc245fa	97,327
1.5% Ramsey	2022	hfc245fa	100,972
1.5% Ramsey	2023	hfc245fa	104,617
1.5% Ramsey	2024	hfc245fa	108,262
1.5% Ramsey	2025	hfc245fa	111,907
1.5% Ramsey	2026	hfc245fa	115,551

1.5% Ramsey	2027	hfc245fa	119,196
1.5% Ramsey	2028	hfc245fa	122,841
1.5% Ramsey	2029	hfc245fa	126,486
1.5% Ramsey	2030	hfc245fa	130,131
1.5% Ramsey	2031	hfc245fa	134,305
1.5% Ramsey	2032	hfc245fa	138,480
1.5% Ramsey	2033	hfc245fa	142,655
1.5% Ramsey	2034	hfc245fa	146,830
1.5% Ramsey	2035	hfc245fa	151,004
1.5% Ramsey	2036	hfc245fa	155,179
1.5% Ramsey	2037	hfc245fa	159,354
1.5% Ramsey	2038	hfc245fa	163,529
1.5% Ramsey	2039	hfc245fa	167,704
1.5% Ramsey	2040	hfc245fa	171,878
1.5% Ramsey	2041	hfc245fa	176,353
1.5% Ramsey	2042	hfc245fa	180,827
1.5% Ramsey	2043	hfc245fa	185,302
1.5% Ramsey	2044	hfc245fa	189,776
1.5% Ramsey	2045	hfc245fa	194,251
1.5% Ramsey	2046	hfc245fa	198,725
1.5% Ramsey	2047	hfc245fa	203,200
1.5% Ramsey	2048	hfc245fa	207,674
1.5% Ramsey	2049	hfc245fa	212,149
1.5% Ramsey	2050	hfc245fa	216,623
1.5% Ramsey	2020	hfc43_10	231,931
1.5% Ramsey	2021	hfc43_10	238,798
1.5% Ramsey	2022	hfc43_10	245,664
1.5% Ramsey	2023	hfc43_10	252,531
1.5% Ramsey	2024	hfc43_10	259,397
1.5% Ramsey	2025	hfc43_10	266,264
1.5% Ramsey	2026	hfc43_10	273,131
1.5% Ramsey	2027	hfc43_10	279,997
1.5% Ramsey	2028	hfc43_10	286,864
1.5% Ramsey	2029	hfc43_10	293,730
1.5% Ramsey	2030	hfc43_10	300,597
1.5% Ramsey	2031	hfc43_10	308,074
1.5% Ramsey	2032	hfc43_10	315,551
1.5% Ramsey	2033	hfc43_10	323,029
1.5% Ramsey	2034	hfc43_10	330,506
1.5% Ramsey	2035	hfc43_10	337,983
1.5% Ramsey	2036	hfc43_10	345,460
1.5% Ramsey	2037	hfc43_10	352,937
1.5% Ramsey	2038	hfc43_10	360,415
1.5% Ramsey	2039	hfc43_10	367,892
1.5% Ramsey	2040	hfc43_10	375,369
1.5% Ramsey	2041	hfc43_10	383,509
1.5% Ramsey	2042	hfc43_10	391,649

1.5% Ramsey	2043	hfc43_10	399,789
1.5% Ramsey	2044	hfc43_10	407,929
1.5% Ramsey	2045	hfc43_10	416,068
1.5% Ramsey	2046	hfc43_10	424,208
1.5% Ramsey	2047	hfc43_10	432,348
1.5% Ramsey	2048	hfc43_10	440,488
1.5% Ramsey	2049	hfc43_10	448,628
1.5% Ramsey	2050	hfc43_10	456,768
1.5% Ramsey	2020	hfc23	4,171,939
1.5% Ramsey	2021	hfc23	4,240,041
1.5% Ramsey	2022	hfc23	4,308,144
1.5% Ramsey	2023	hfc23	4,376,246
1.5% Ramsey	2024	hfc23	4,444,348
1.5% Ramsey	2025	hfc23	4,512,450
1.5% Ramsey	2026	hfc23	4,580,553
1.5% Ramsey	2027	hfc23	4,648,655
1.5% Ramsey	2028	hfc23	4,716,757
1.5% Ramsey	2029	hfc23	4,784,860
1.5% Ramsey	2030	hfc23	4,852,962
1.5% Ramsey	2031	hfc23	4,920,863
1.5% Ramsey	2032	hfc23	4,988,763
1.5% Ramsey	2033	hfc23	5,056,664
1.5% Ramsey	2034	hfc23	5,124,565
1.5% Ramsey	2035	hfc23	5,192,466
1.5% Ramsey	2036	hfc23	5,260,366
1.5% Ramsey	2037	hfc23	5,328,267
1.5% Ramsey	2038	hfc23	5,396,168
1.5% Ramsey	2039	hfc23	5,464,068
1.5% Ramsey	2040	hfc23	5,531,969
1.5% Ramsey	2041	hfc23	5,608,539
1.5% Ramsey	2042	hfc23	5,685,109
1.5% Ramsey	2043	hfc23	5,761,679
1.5% Ramsey	2044	hfc23	5,838,249
1.5% Ramsey	2045	hfc23	5,914,819
1.5% Ramsey	2046	hfc23	5,991,389
1.5% Ramsey	2047	hfc23	6,067,959
1.5% Ramsey	2048	hfc23	6,144,528
1.5% Ramsey	2049	hfc23	6,221,098
1.5% Ramsey	2050	hfc23	6,297,668
1.5% Ramsey	2020	hfc134a	153,232
1.5% Ramsey	2021	hfc134a	158,622
1.5% Ramsey	2022	hfc134a	164,012
1.5% Ramsey	2023	hfc134a	169,402
1.5% Ramsey	2024	hfc134a	174,792
1.5% Ramsey	2025	hfc134a	180,182
1.5% Ramsey	2026	hfc134a	185,572
1.5% Ramsey	2027	hfc134a	190,962

1.5% Ramsey	2028	hfc134a	196,351
1.5% Ramsey	2029	hfc134a	201,741
1.5% Ramsey	2030	hfc134a	207,131
1.5% Ramsey	2031	hfc134a	213,062
1.5% Ramsey	2032	hfc134a	218,992
1.5% Ramsey	2033	hfc134a	224,923
1.5% Ramsey	2034	hfc134a	230,853
1.5% Ramsey	2035	hfc134a	236,784
1.5% Ramsey	2036	hfc134a	242,714
1.5% Ramsey	2037	hfc134a	248,645
1.5% Ramsey	2038	hfc134a	254,575
1.5% Ramsey	2039	hfc134a	260,506
1.5% Ramsey	2040	hfc134a	266,436
1.5% Ramsey	2041	hfc134a	272,824
1.5% Ramsey	2042	hfc134a	279,213
1.5% Ramsey	2043	hfc134a	285,601
1.5% Ramsey	2044	hfc134a	291,989
1.5% Ramsey	2045	hfc134a	298,378
1.5% Ramsey	2046	hfc134a	304,766
1.5% Ramsey	2047	hfc134a	311,155
1.5% Ramsey	2048	hfc134a	317,543
1.5% Ramsey	2049	hfc134a	323,931
1.5% Ramsey	2050	hfc134a	330,320
1.5% Ramsey	2020	hfc227ea	527,571
1.5% Ramsey	2021	hfc227ea	541,320
1.5% Ramsey	2022	hfc227ea	555,068
1.5% Ramsey	2023	hfc227ea	568,817
1.5% Ramsey	2024	hfc227ea	582,565
1.5% Ramsey	2025	hfc227ea	596,313
1.5% Ramsey	2026	hfc227ea	610,062
1.5% Ramsey	2027	hfc227ea	623,810
1.5% Ramsey	2028	hfc227ea	637,559
1.5% Ramsey	2029	hfc227ea	651,307
1.5% Ramsey	2030	hfc227ea	665,055
1.5% Ramsey	2031	hfc227ea	679,534
1.5% Ramsey	2032	hfc227ea	694,013
1.5% Ramsey	2033	hfc227ea	708,492
1.5% Ramsey	2034	hfc227ea	722,971
1.5% Ramsey	2035	hfc227ea	737,449
1.5% Ramsey	2036	hfc227ea	751,928
1.5% Ramsey	2037	hfc227ea	766,407
1.5% Ramsey	2038	hfc227ea	780,886
1.5% Ramsey	2039	hfc227ea	795,365
1.5% Ramsey	2040	hfc227ea	809,843
1.5% Ramsey	2041	hfc227ea	825,949
1.5% Ramsey	2042	hfc227ea	842,055
1.5% Ramsey	2043	hfc227ea	858,161

1.5% Ramsey	2044	hfc227ea	874,267
1.5% Ramsey	2045	hfc227ea	890,373
1.5% Ramsey	2046	hfc227ea	906,479
1.5% Ramsey	2047	hfc227ea	922,585
1.5% Ramsey	2048	hfc227ea	938,691
1.5% Ramsey	2049	hfc227ea	954,797
1.5% Ramsey	2050	hfc227ea	970,903
1.5% Ramsey	2020	hfc236fa	2,708,096
1.5% Ramsey	2021	hfc236fa	2,751,609
1.5% Ramsey	2022	hfc236fa	2,795,122
1.5% Ramsey	2023	hfc236fa	2,838,635
1.5% Ramsey	2024	hfc236fa	2,882,149
1.5% Ramsey	2025	hfc236fa	2,925,662
1.5% Ramsey	2026	hfc236fa	2,969,175
1.5% Ramsey	2027	hfc236fa	3,012,688
1.5% Ramsey	2028	hfc236fa	3,056,202
1.5% Ramsey	2029	hfc236fa	3,099,715
1.5% Ramsey	2030	hfc236fa	3,143,228
1.5% Ramsey	2031	hfc236fa	3,186,505
1.5% Ramsey	2032	hfc236fa	3,229,782
1.5% Ramsey	2033	hfc236fa	3,273,059
1.5% Ramsey	2034	hfc236fa	3,316,336
1.5% Ramsey	2035	hfc236fa	3,359,613
1.5% Ramsey	2036	hfc236fa	3,402,890
1.5% Ramsey	2037	hfc236fa	3,446,167
1.5% Ramsey	2038	hfc236fa	3,489,443
1.5% Ramsey	2039	hfc236fa	3,532,720
1.5% Ramsey	2040	hfc236fa	3,575,997
1.5% Ramsey	2041	hfc236fa	3,624,794
1.5% Ramsey	2042	hfc236fa	3,673,590
1.5% Ramsey	2043	hfc236fa	3,722,387
1.5% Ramsey	2044	hfc236fa	3,771,183
1.5% Ramsey	2045	hfc236fa	3,819,980
1.5% Ramsey	2046	hfc236fa	3,868,776
1.5% Ramsey	2047	hfc236fa	3,917,572
1.5% Ramsey	2048	hfc236fa	3,966,369
1.5% Ramsey	2049	hfc236fa	4,015,165
1.5% Ramsey	2050	hfc236fa	4,063,962

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From file: Cylinder Heel Recovery_Final_HFC emissions reductions.xlsx
and: cylinder_mgmt_emissions_reductions_ERR_final_rule_4.16.24.xlsx

			Absolute Emission Reductions (Metric tons		
			Cylinder Management Reductions		
Year	HFC-32	HFC-134a	HFC-236fa	HFC-245fa	HFC-125
2025	0	0	0	0	0
2026	0	0	0	0	0
2027	0	0	0	0	0
2028	679.8962	203.45503	0	0.437690406	331.5145903
2029	686.3105	190.59896	0	0.441919397	312.4090057
2030	692.9413	176.21603	0	0.445505572	291.9859525
2031	699.6409	161.10533	0	0.44907361	270.9619506
2032	706.4076	147.63897	0	0.452811288	249.3007577
2033	712.8614	135.8924	0	0.456408109	227.410599
2034	720.1773	125.91351	0	0.460682869	204.2607287
2035	727.8369	117.95569	0	0.465124697	180.4186281
2036	735.725	112.12713	0	0.469615595	156.0385546
2037	742.9799	108.57482	0	0.474061346	131.1053983
2038	749.4813	104.57885	0	0.477320609	111.8712122
2039	755.2301	100.17182	0	0.479399624	98.57329644
2040	759.4862	95.357317	0	0.480095321	92.55086628
2041	763.9469	90.427773	0	0.480824567	86.3933059
2042	768.5005	85.476754	0	0.481407862	80.36043133
2043	772.6128	81.442179	0	0.434718011	75.42865292
2044	775.6846	79.348295	0	0.340067027	72.6401106
2045	778.335	77.559846	0	0.220555792	70.4098282
2046	779.9736	76.072435	0	0.12290349	69.18063551
2047	781.381	74.831696	0	0.050938857	68.18110943
2048	782.5465	73.842645	0	0.011465663	67.41864199
2049	783.4263	73.144813	0	0.003859621	66.9227668
2050	783.8701	72.782107	0	0	66.53757081

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HFC-143a	HFC-227ea	HFC-23
0	0	0
0	0	0
0	0	0
80.51762	0	0
75.63324	0	0
70.89513	0	0
66.71384	0	0
62.71917	0	0
59.4121	0	0
55.20205	0	0
50.71869	0	0
46.06848	0	0
42.79663	0	0
39.28305	0	0
35.55273	0	0
31.63994	0	0
27.65707	0	0
23.82601	0	0
20.12743	0	0
16.56236	0	0
13.4313	0	0
11.45828	0	0
9.697968	0	0
8.157443	0	0
6.861697	0	0
6.479443	0	0

From file: "Tier 2 Draft Emissions MACC Options_4.15.24_ERR Base"
and: fire_suppression_emissions_reductions_ERR_final_rule_4.16.24.xlsx

			Absolute Emission Reductions (Metric tons		
				Fire Suppression	
Year	HFC-32	HFC-134a	HFC-236fa	HFC-245fa	HFC-125
2025	0	0	0	0	0
2026	0	0	0	0	0.8411
2027	0	0	0	0	0.8602
2028	0	0	0	0	0.87915
2029	0	0	0	0	0.89845
2030	0	0	0	0	0.91825
2031	0	0	0	0	0.93765
2032	0	0	0	0	0.9567
2033	0	0	0	0	0.9754
2034	0	0	0	0	0.99365
2035	0	0	0	0	1.01155
2036	0	0	0	0	1.029
2037	0	0	0	0	1.046
2038	0	0	0	0	1.06255
2039	0	0	0	0	1.07865
2040	0	0	0	0	1.09425
2041	0	0	0	0	1.10935
2042	0	0	0	0	1.12395
2043	0	0	0	0	1.13795
2044	0	0	0	0	1.1514
2045	0	0	0	0	1.1643
2046	0	0	0	0	1.1766
2047	0	0	0	0	1.18825
2048	0	0	0	0	1.1993
2049	0	0	0	0	1.20965
2050	0	0	0	0	1.2193

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HFC-143a	HFC-227ea	HFC-23
0	0	0
0	1.05185	0.0174
0	1.07225	0.0178
0	1.09445	0.0182
0	1.1178	0.0186
0	1.1424	0.019
0	1.16655	0.0194
0	1.19025	0.0198
0	1.2135	0.02015
0	1.23625	0.02055
0	1.2585	0.0209
0	1.2802	0.0213
0	1.30135	0.02165
0	1.32195	0.022
0	1.342	0.0223
0	1.3614	0.02265
0	1.38015	0.02295
0	1.3983	0.02325
0	1.41575	0.02355
0	1.4325	0.0238
0	1.44855	0.0241
0	1.46385	0.02435
0	1.47835	0.0246
0	1.49205	0.0248
0	1.50495	0.025
0	1.517	0.0252

From file: "Tier 2 Draft Emissions MACC Options_4.15.2024_ERR Base"
and: LR_ALD_emissions_reductions_ERR_final_rule_4.16.24.xlsx

			Absolute Emission Reductions (Metric tons		
				Leak Repair and ALD	
Year	HFC-32	HFC-134a	HFC-236fa	HFC-245fa	HFC-125
2025	0	0	0	0	0
2026	240.1108	805.09748	0.133125222	15.5634091	661.2722983
2027	278.0604	876.6108	0.044434201	15.5634091	758.6660836
2028	284.7789	861.51947	0	15.5634091	743.686471
2029	290.7628	836.57823	0	15.5634091	729.0145163
2030	294.792	803.24733	0	15.5634091	712.937765
2031	296.9736	769.83999	0	15.5634091	696.0162247
2032	297.1596	735.21528	0	15.5634091	676.4403095
2033	295.3783	700.38844	0	15.5634091	656.4095867
2034	293.1054	668.75344	0	15.5634091	633.0027206
2035	283.1541	624.82568	0	15.5634091	589.3674206
2036	274.0682	581.29403	0	15.5634091	547.4758684
2037	264.9932	537.01868	0	15.5634091	504.8933716
2038	255.9788	491.96953	0	15.5634091	461.4393431
2039	247.0952	446.09307	0	15.5634091	417.0620427
2040	238.4428	399.32212	0	15.5634091	371.7855933
2041	234.6111	357.20256	0	15.5634091	331.6646583
2042	223.378	304.37827	0	15.5634091	281.0766351
2043	215.9016	258.95756	0	14.02410662	238.8866262
2044	215.6345	227.84278	0	10.93010865	212.0260552
2045	216.6305	201.35546	0	7.027883789	190.7827063
2046	218.1612	177.81298	0	3.87193478	172.9745163
2047	220.2543	158.15713	0	1.573367658	158.1762989
2048	222.9385	142.56319	0	0.314274227	146.5488304
2049	225.6296	131.67395	0	0.105106688	138.5340365
2050	227.7307	125.86296	0	0	133.6154417

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HFC-143a	HFC-227ea	HFC-23
0	0	0
389.7849	0	0
445.8188	0	0
427.0488	0	0
410.3572	0	0
395.5478	0	0
383.1354	0	0
371.3909	0	0
362.7798	0	0
348.0171	0	0
325.4056	0	0
304.4639	0	0
283.158	0	0
261.2972	0	0
238.8391	0	0
215.8319	0	0
197.354	0	0
169.2346	0	0
141.9845	0	0
115.6295	0	0
93.08681	0	0
73.62531	0	0
56.72106	0	0
42.51177	0	0
31.37368	0	0
26.29799	0	0

RCRA Alternative Standards for Ignitable Spent Refrigerants:

Response to Comments Document

Docket ID: EPA-HQ-OAR-2022-0606

Introduction

On October 19, 2023, EPA published the proposed Emissions Reduction and Reclamation rule, which implements one of the goals of the American Innovation and Manufacturing Act, namely, to promulgate regulations for purposes of maximizing reclamation and minimizing releases from the management of certain hydrofluorocarbons (HFCs) and their substitutes. (88 FR 72216)

As part of the same Federal Register notice, EPA proposed, under the authority of the Resource Conservation and Recovery Act (RCRA), alternative RCRA recycling standards for ignitable spent refrigerants, including some HFCs and their substitutes.

This document contains the comments and EPA responses on only the RCRA proposed changes. The comment excerpts were taken verbatim from the comments submitted to EPA and are grouped by subject area. The comment ID number listed next to each comment excerpt corresponds to the last four numbers of the number in the EPA Docket for each comment. EPA's response to each group of comments is found in each table immediately following the grouped comments. The list of commenters who commented on the RCRA proposed changes and their full comment ID number is found in the Appendix to this document.

All comments and supporting documents for the rule (including this document) can be found in EPA docket #EPA-HQ-OAR-2022-0606, which can be accessed via regulations.gov.

Contents

#	Section 1.0 Support for the Proposed RCRA Alternative Standards
0102	We fully support changing the RCRA standards for the benefit of the environment to allow and promote the reclamation of A2 and A2L refrigerants in the same manner as A1 refrigerants.
0109	A-Gas generally supports EPA's proposed requirements under RCRA as they would apply to A2L refrigerants, as these requirements generally reflect A-Gas existing operating practices and procedures at its facilities in Bowling Green, Ohio, and Rhome, Texas.
0110	Koura generally supports the EPA on the RCRA requirement
0113	National strongly supports EPA's proposal to apply RCRA alternative standards to ignitable spent refrigerants
0121	AHRI and the Alliance generally support EPA's proposed treatment of regulated substances under the AIM Act under a new and less onerous standard under RCRA.
0139	CARB supports EPA's proposed alternative RCRA standards for spent ignitable HFC refrigerants, as was similarly established for the CFC refrigerant recycling exclusion in 1991.The alternative RCRA standards EPA has proposed would apply to HFCs and substitutes that do not belong to flammability Class 3, as classified by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 34–2022, when recycled for reuse. These proposed alternative RCRA standards would increase recovery of mildly flammable refrigerants, reduce emissions, and actualize the goals of the AIM Act.
0145	Trane Technologies thanks the Agency for addressing this issue. Updates for new refrigerants and blends in the RCRA standards as a critical step to ensure proper recovery, reuse, and disposal of regulated substances at end of life. We look forward to the finalization of this modification.
EPA Response: EPA appreciate the support for the proposed RCRA alternative standards for ignitable spent refrigerants.	

#	Section 2.0 Proposed Scope of the RCRA Alternative Standards
#	**Section 2.1 Scope of the RCRA Alternative Standards Should Be Expanded.**
0111	We strongly support the widest possible exclusion from burdensome RCRA requirements for reclaimers, including that… the scope of the proposed alternative standards should include Class 1, Class 2, Class 2L, and Class 3 flammable substances; (b) the limits for speculative accumulation are eliminated or significantly adjusted to reflect production facility requirements at fractionation facilities; (c) the proposed requirement that reclamation facilities processing ignitable refrigerants meet the standards under 40 CFR part 261, subpart M, Emergency Preparedness and Response for Management of Excluded Hazardous Secondary Materials should be eliminated; and (d) the requirement that all batches of reclaimed material meet ASHRAE standards (or manage the off-spec material under RCRA) should be lifted. The application of RCRA to HFC recycling exemplifies one of the substantial administrative and financial burdens that, if imposed on EPA-certified reclaimers, would increase the challenges for reclamation to reach its full and expected potential. We therefore support the widest possible application of the alternative RCRA standards, with the fewest possible conditions, at least with respect to operations that take place at EPA-certified off-site reclamation facilities. Particularly in advanced facilities designed to safely fractionate former patented blends of HFCs and small waste streams, it is unreasonable and unnecessary to propose the costliest solutions considering the 1.6% reclamation rate. Given the 98.4% release rate, it is unlikely that substantial quantities of hydrocarbon-containing former patent blends of HFCs will return to EPA-certified reclaimers. Accordingly, we recommend that the EPA instead allow insurance companies and local fire and building code authorities for each reclaimer to identify key risk characteristics and develop mitigation strategies, rather than imposing huge and unnecessary administrative and cost burdens on HFC reclaimers via default RCRA requirements.
0111	First, we do not support the EPA’s proposal to exclude Class 3 flammable substances, either in their pure form or typically found as components in Class A1 low flammability products like Chemours M099 (R438A), from the RCRA alternative handling standards
0139	CARB also supports EPA’s consideration of expanding these [RCRA] reclamation requirements to include flammability Class 3 refrigerants in the future.
EPA response: EPA disagrees with comments that support expanding the scope of the RCRA alternative standards to include highly flammable (Class 3) ignitable spent refrigerants. EPA proposed to limit the alternative standards to lower flammability substitutes (Class 1, 2 and 2L) because of the lower risk of fire from the collection and recycling for reuse of these refrigerants, and the greater market value of these refrigerants, which supports the conclusion that these spent refrigerants will be recycled for reuse and not stockpiled, mismanaged, or abandoned. (88 FR 72275) Comments did not address the safety or feasibility of expanding the standards to include Class 3 refrigerants, and therefore EPA is finalizing these provisions as proposed. (Comments regarding reducing the specific requirements in the standards are addressed in Section 3.0 of this comment response document, found below).	

0158	As its title indicates, Ignitable Spent Refrigerants Recycled for Reuse, proposed Subpart Q is limited to ignitable spent refrigerants. Ignitability is not the only possible reason that a spent refrigerant could be a hazardous waste. The corrosivity of spent CFC refrigerant—due to the presence of hydrochloric acid from degradation of CFCs during use as a refrigerant— was the reason that the hazardous waste exclusion at § 261.4(b)(12) was created for certain used CFC refrigerant that is reclaimed. By removing a RCRA Subtitle C regulatory barrier, this exclusion facilitated the reclamation of used CFC refrigerants for reuse. In the case of regulated substances (i.e., certain HFCs) and their substitutes, they do not and will not contain chlorine. Given that the pKa of HF (~3.2) is much greater than the pKa of HCl (~-6) 22, a spent HFC refrigerant seems unlikely to exhibit the hazardous waste characteristic of corrosivity; however, that it cannot exhibit corrosivity is not a certainty. To account for this possibility and to eliminate the RCRA Subtitle C regulatory uncertainty, ISRI recommends that the scope of Subpart Q be expanded beyond ignitable spent refrigerants to include also spent refrigerants that exhibit the hazardous waste characteristic of corrosivity. Such expansion of the scope of Subpart Q further supports the goal of AIM Act Subsection (h) to safely maximize reclamation of HFCs from equipment and to safely minimize their releases.
EPA response: EPA disagrees with the comment to the extent that it suggests that the proposed RCRA alternative standards were designed to address risk of corrosivity. The proposed RCRA alternative standards were not designed to address risk of corrosivity.	
#	**Section 2.2 Scope of the RCRA Alternative Standards Should be Narrowed.**
0085	Chemours supports alternative standards covering ASHRAE Class A2L but not A2 or B2L refrigerants. Reclaim facilities modifications to handle higher burning velocity gases (A2) or refrigerants with Class B toxicity rating (e.g., ammonia is a B2L) may slow ability to meet reclaim timeline so requirements should be limited to A2L. Because A2L products are critical to meeting the deadlines outlined in the Technology Transitions rule, EPA should consider phasing in requirements for other ASHRAE classes in future years to allow time for infrastructure development. But Chemours does not support expansion to products that include A3 refrigerants because their high flammability (low LFL, high burning velocity) would greatly increase risk for technicians and reclaimers and slow facility preparedness for handling lower flammability refrigerants.
0121	AHRI and the Alliance propose narrowing the scope to Class A Toxicity and Class 2L Flammability (and not ASHRAE Flammability Class 2L, 2, and 3).
EPA response: EPA disagrees with the comments. While any reclaimer may choose to only accept A2L refrigerants, limiting the alternative standards to only A2L refrigerants would unnecessarily prevent reclaimers who wish to invest in reclaiming those refrigerants from accepting them.	
#	**Section 2.3 Identification of Ignitable Spent Refrigerants Subject to RCRA Alternative Standards**
0102	It may not be clear which refrigerants received are A2L refrigerants. R-410a is not an A2L refrigerant and is composed of 50% R-32 and 50% R-125. R-32 is an A2L refrigerant and will be used as a standalone refrigerant. When does R-410A mixed with R-32 become an A2L? at what percentage does this rule become effective. Reclaimers work with most of the

	ARI approved refrigerants which at last count were over 150 fluorocarbon components and blends, each combination of refrigerants received would have to be evaluated to see if it is now an A2L refrigerant. A2L refrigerants may be created from non-A2L refrigerants during processing. Several reclaimers have fractional distillation tower capacity. If R-410a or refrigerants mixed with R-410a (a non-A2L refrigerant) is partially separated and the material removed from the collector (the low boiler components concentrate in the collector) is primarily R-32, does this material now qualify under the non-speculation rule and must be processed or destroyed in in 12 months? How is this material any different from A2L mixtures received though collection?
0129	EPA does try to define ignitable, which may be out of sync with the marketplace, so we seek clarity related to what is considered ignitable per EPA accepting the concept that there is a difference between AHRI and OSHA/NIOSH terms for the same activity (ignitable). c. For instance, R-152A has a GWP of 124 and is listed as an A2, but it is classed as RCRA D001yet no one, as you have stated, needs to modify their practices or meet any new RCRA requirements. The supply chain will be responsible for handling, transporting, and storing these materials so we seek clarity on these specific items when you publish your final rule.
0111	In particular, the act of reclaiming Class 1 materials that may contain minimal Class 3 flammables should not trigger costly process safety management compliance or RCRA compliance at the reclamation facility

EPA response: RCRA hazardous waste requirements only apply to spent refrigerants if they exhibit a hazardous waste characteristic, regardless of their ASHRAE Class. It is the generator's responsibility under 40 CFR 262.11 to determine if their waste meets the definition of hazardous waste under RCRA. Refrigerants that are flammable under ASHRAE Class A2, A2L and A3 are expected to exhibit the hazardous waste characteristic of ignitability under 40 CFR 261.21, unless testing were to demonstrate otherwise. For mixtures of A2L and non-A2L refrigerants, the refrigerant would be subject to RCRA requirements if it exhibits the ignitability characteristic.

The RCRA hazardous waste characteristic of ignitability is defined in the regulations at 40 CFR 261.21. Under this standard, compressed gases (defined as "any material or mixture having in the container an absolute pressure exceeding 40 p.s.i. at 70 °F or, regardless of the pressure at 70 °F, having an absolute pressure exceeding 104 p.s.i. at 130 °F; or any liquid flammable material having a vapor pressure exceeding 40 p.s.i. absolute at 100 °F as determined by ASTM Test D–323) are ignitable if any one of the following occurs:

(1) Either a mixture of 13 percent or less (by volume) with air forms a flammable mixture, or the flammable range with air is wider than 12 percent regardless of the lower limit. These limits shall be determined at atmospheric temperature and pressure. The method of sampling and test procedure shall be the ASTM E 681–85 (incorporated by reference, see § 260.11 of this subchapter), or other equivalent methods approved by the Associate Administrator, Pipeline and Hazardous Materials Safety Administration, U.S. Department of Transportation.

(2) It is determined to be flammable or extremely flammable using 49 CFR 173.115(l).

#	Section 3.0 Proposed Requirements of the RCRA Alternative Standards
	Section 3.1 Speculative Accumulation Limits
0084	I have concerns with the EPA's proposed limitations on speculative accumulation, regarding sites receiving recovered or recycled flammable refrigerants. Requiring reclaimers to process 75% of these refrigerants within one year will be very challenging for most reclaimers. If this stipulation is not met, the recovered refrigerants would become hazardous waste and fall under RCRA regulations. That is alarming, because in the ordinary course of running a reclamation business, certain refrigerants can accumulate for one or more years before being processed. There is often a mismatch between market demand and refrigerants received. When specific refrigerants are not in immediate demand, it is still in all parties' best interest that reclaimers accumulate them for future market needs. Refrigerant reclamation does not always begin immediately upon receipt of recovered refrigerants – there is often a lengthy accumulation phase. Batches of like material are accumulated for varying periods of time before being processed. It can take anywhere from days to years before a sufficiently sized batch of recovered refrigerant has been accumulated to justify reclaiming and certifying the product. For example, if a reclaimer were to receive a specific recovered refrigerant in quantities of a few pounds each month, it would not make sense to reclaim such a small batch for well over a year. It could potentially take several years before the batch size had grown to a scale that was economical to process.
0085	Finally, EPA proposes that ignitable spent refrigerants should not be speculatively accumulated as defined in 40 CFR §261.1(c). As opposed to EPA's proposed alternative, Chemours proposes that an initial, extended accumulation period should be allowed for recovered TT compliant Class A2L refrigerants (e.g., for 5 years) due to a very small initial installed equipment base and low equipment service rates in first years of operation. Limiting the accumulation period to a one year maximum would require processing of extremely small quantities which would be an inefficient use of reclaimer resources.
0102	However, the additional requirement that the refrigerants are not speculatively accumulated as defined in 40 CFR 261.1(c) ignores the realities of the reclama⍰on industry and would place great burden on most reclaimers. Reclaimers must compete for the supply of recovered refrigerants to have material to process. To provide an effective solution to the customer, whether it is a wholesaler, contractor or other aggregator of recovered refrigerant, the reclaimer must be able to accept all refrigerants and refrigerant mixtures. If a reclaimer could or would turn away refrigerants it greatly increases the chances that the refrigerant would be illegally vented. The average contractor, wholesaler, or aggregator has relatively little to no access to most destruction facilities and no entity in the supply chain is better equipped to collect, store, and properly handle otherwise unwanted refrigerants. There are several reasons why these refrigerants may not be able to be reclaimed within a 12-month period. The refrigerants a reclaimer receives are usually not in proportion with the refrigerants the marketplace is demanding. Reclaimers receiving refrigerants which are not in demand will usually set these refrigerants aside and use their manufacturing capacity towards refrigerants that needed currently by the markets. Refrigerants are not always received in reclaimable quantities. Reclama⍰on is usually done in large batches once enough material is accumulated to efficiently process. When refrigerants are received in smaller quantities, they are stored un⍰l a reasonable amount

	of material has been accumulated. With some A1 refrigerants, a reclamaon batch may be run infrequently with as much as several years between batches. Requiring reclaimers to run a batch every 12 months or to destroy the material would add cost and complexity to a process that works well in its current state. Reclaimers receive refrigerant blends which are patented and out of specification. EPA regulations prohibit the reintroduction of the patented refrigerant blends if aer reclamaon they do not meet the full ARI 700 specification. Patent laws, which are vigorously enforced by chemical producers, prohibit the addition of any material that is not also the patented blend. Reclaimers should have the right to store this material unl a usable solution to return this material to the market is found. Reclaimers receive mixed refrigerants which may be waiting on the development of additional technologies to separate and process. The AIM act itself provides for grants to entities to be used to invest in and develop new technologies however, this rule would not allow refrigerants to be set aside for more than 12 months while these grants are used to develop the technologies. Reclaimers would have to ensure that they had excess manufacturing capacity prior to receiving refrigerants. Many solutions are being proposed to increase the amount of refrigerant being turned in for reclamaon. If a solution is found and implemented most everyone would consider the additional capture of refrigerants as an environmental benefit. Reclaimers may be placed in the uncomfortable position that they would not be allowed to accumulate additional refrigerant while they build additional processing capacity due to the non-accumulation rule.
0102	The AIM act directs the EPA to establish regulations for purposes of maximizing reclamation, the non-accumulation rule would reduce reclamation and increase destruction. It could also dampen the acceptance of A2L refrigerants by reclaimers as it increases the cost and complexity of working with them without providing benefit to the reclaimer.
0109	However, A-Gas does not support – and, in fact, opposes – any limitation on the ability of a certified reclaimer to store quantities of recovered material on site. A-Gas respectfully requests EPA allow such storage for an unlimited amount of time and free of any special requirements and not consider it under RCRA or otherwise as speculative stockpiling. This is because a reclaimer often receives recovered materials as they become available and must hold them until market conditions create sufficient demand for reclamation and sale. The timing is difficult to predict and will vary both throughout the year and from year to year. Affirmative requirements under RCRA regarding speculative stockpiling or otherwise risks significantly undermining a reclaimer's ability to receive recovered gas. Ultimately, such a requirement poses serious risk to the reclaim industry's potential to increase the supply of reclaimed gas in response to market demand. In other words: reclaimers need to be able to receive and store recovered gas indefinitely, without incurring additional or excessive costs or compliance burdens.
0111	Second, we do not support the proposed requirement that the alternative standards apply only if storage at the off-site reclamation facility falls below the existing thresholds for "RCRA speculative accumulation," and that large volumes of ignitable refrigerants destined for reclamation can be safely accumulated and handled and need not fall into a specified category of RCRA-regulated wastes when accumulating ignitable spent refrigerants for fractionation. Accordingly, such accumulations should not be misconstrued as speculative storage of flammable components. Expanding reclamation capacity, including through fractionation, will necessarily lead to the short-term accumulation of refrigerants before processing due to the size of assets requiring larger inbound feed volumes than currently available. The RCRA speculative accumulation limits for reclamation feedstock, and likewise

	the emergency preparedness requirements – neither of which apply to analogous virgin production facilities despite identical risks associated with ignitable virgin components – create an unlevel playing field between reclaimers and virgin HFC producers. Moreover, it is crucial to highlight that the presence of mixed HFCs in railcars across various HFC Coalition member facilities renders the impracticality of processing all reclaims within a single year, introducing an additional obstacle to mitigating the 98.4% refrigerant release rate. The focus should pivot from the 1.6% adherence to responsible practices to tackling the 98.4% release rate on a product-specific basis
0113	National also recommends that EPA's proposed requirements that refrigerants not be speculatively accumulated per 40 C.F.R. § 261.1(c) be revised as they apply to class 2 and 2L refrigerants to allow for storage beyond the current one calendar year limit, as long as it can be shown that the material has a feasible means of being recycled. We believe this change is necessary since processing and batching practices allow for the analysis and storage of accumulated recovered refrigerant that often extend past a calendar year, and the need to address market demands and operating efficiencies could lead to storage beyond one year. Moreover, material comes in throughout the year, so the deadline is impractical. As currently drafted, EPA's proposed restriction on speculatively accumulated HFCs could lead to unnecessary disposal and destruction of useful material. This would obviously undermine the goals of subsection (h) and thus not be supported under the AIM Act
159	"Speculatively accumulated" means that at least 75 percent of the material is recycled within one year. This could be problematic for many reclaimers for several reasons. Refrigerants are not always received in reclaimable quantities, and reclamation is usually done in large batches once enough material is accumulated to process efficiently. Because refrigerants are received in smaller quantities and stored until a reasonable amount of material has been accumulated, the proposed one-year time limit is not workable. Reclaimers also receive refrigerant blends, which may be both patented and out of specification, and imposing a one-year time limit on these blends could foreseeably lead to the need to destroy refrigerants (i.e., accumulated beyond one year) that otherwise could be reclaimed. Reclaimers should have the ability to store this material until a usable solution to return this material to the market is found.
EPA response: See discussion in the final rule preamble in Section IV.H.3.	

#	**Section 3.2 Emergency Preparedness and Response Requirements**
0113	However, we believe the proposed emergency response, training, and very small quantity generator ("VSQG") requirements should be applied only when the reclaimer is not already subject to similar existing regulatory requirements, such as under U.S. Occupational Safety and Health Administration ("OSHA") Process Safety Management ("PSM"), Emergency Action Plan ("EAP"), and Hazard Communication Standard ("HCS") requirements at its facility. While we believe EPA's proposed alternative RCRA standards will provide incentives for the recapture and safe recycling of HFC refrigerants and contribute to a safer work environment for industry employees, our proposed clarification will eliminate the potential for duplicative requirements that would increase the regulatory burden without enhancing safety beyond the requirements already in effect.

EPA response: As noted in the proposed rule preamble, EPA proposed the requirement that facilities receiving refrigerant to be recycled for reuse meet the RCRA standards under 40 CFR part 261, subpart M, Emergency Preparedness and Response for Management of Excluded Hazardous Secondary Materials because these third-party recyclers would be receiving ignitable spent refrigerant from multiple sources, and are likely to store greater volumes for longer time periods than companies that recycle for reuse onsite or as part of an MVAC refrigerant recovery and recycling system in compliance with 40 CFR part 82, subpart B. (88 FR 72276) The proposed requirements included maintaining appropriate emergency equipment on site, having access to alarm systems, maintaining needed aisle space, making arrangements with local emergency authorities, and having a designated emergency coordinator who is responsible for responding in the event of an emergency. These requirements are designed to help protect human health and the environment in the event of a fire or other emergency at the recycler.

However, it should be noted that according to 40 CFR 261.420(b)(2), if a facility already has an emergency response or contingency plan, it need only amend the plan to incorporate those provisions needed to comply with the requirements. EPA recommends that the plan be based on the National Response Team's Integrated Contingency Plan Guidance ("One Plan"). Thus if a facility is already under a plan due to the requirements under U.S. Occupational Safety and Health Administration ("OSHA") Process Safety Management ("PSM"), Emergency Action Plan ("EAP"), or Hazard Communication Standard ("HCS"), and that plan fulfills the requirements of 40 CFR 261 Subpart M, then this provision is met.

#	Section 3.3 Management of Off-Specification Ignitable Refrigerant
0111	Lastly, mandating that reclaimers confirm the compliance of each batch of reclaimed refrigerant with ASHRAE specifications or manage off-spec materials in accordance with RCRA requirements for off-specification commercial chemical products under 40 CFR § 261.2(c) is unduly cumbersome.

EPA response: The regulation of off-spec commercial chemicals under 40 CFR 261.2(c) is an existing RCRA requirement that is not affected by the new RCRA alternative standards for ignitable spent refrigerants. However, it should be noted that if there is an allowable use for the off-spec reclaimed refrigerant and the material is used as an effective substitute for commercial product, it may be exempt from RCRA requirements altogether under the use/reuse provisions of 40 CFR 261.2(e). If the off-spec reclaimed refrigerant goes to further legitimate reclamation, it could also be exempt from RCRA under 40 CFR 261.2(c)(3). If the ignitable off-spec reclaimed refrigerant cannot be either legitimately reused or further reclaimed, it would need to be managed as a hazardous waste.

#	Section 3.4 Applicability to Non-Reclamation Facilities
0152	Further, the preamble discussion's focus on "spent refrigerant being recycled for reuse" seems to overlook the recovery step which, as we understand EPA's intent, is to be regulated in addition to recycling. In other words, the present-tense phrase "being

	recycled" is confusing when applied to the step of recovering refrigerant for future recycling. With respect to the proposed requirements for recycling facilities, the preamble provides: The specific standards that EPA is proposing for facilities receiving refrigerant from offsite to be recycled for reuse are (1) the reclaimer must maintain certification by EPA under 40 CFR 82.164; (2) the facility must meet the emergency preparedness and response requirements of 40 CFR part 261 subpart M, and (3) the ignitable spent refrigerants must not be speculatively accumulated as defined in 40 CFR 261.1(c). Id. at 72,275. Docket # EPA–HQ–OAR–2022-0606 NEDA/CAP's Comments on Proposed HFC Management of HFCs under AIM § (h) December 18, 2023 12 While the preamble discussion of the requirements for recycling facilities appears clear on its face, closer review indicates several needed clarifications
0152	Further, EPA needs to clarify that the duties for facilities "receiving refrigerants" only apply when the receiving facility will actually be performing the recycling; these requirements should not apply if the receiving facility will further transfer the refrigerant to another facility for recycling.
EPA response: See discussion in the final rule preamble in Section IV.H.3.	

#	Section 4.0 Imports and Exports Under the Proposed RCRA Alternative Standard
0085	Chemours does not support imports of recovered refrigerant. If EPA were to permit imports of spent refrigerant, it would be imperative that a full document trail be provided and approved prior to any imports, including manufacturer of unspent refrigerant and refrigerant residence time in the equipment prior to recovery (e.g., to ensure intellectual property rights are not being violated).
EPA Response: EPA disagrees with this comment. As long as the imported refrigerants meet the requirements of the RCRA alternative standard, including being recycled for reuse at an EPA-certified reclaimer per 40 CFR 82.164, EPA finds it unnecessary to also apply the RCRA import requirements in 40 CFR part 262 Subpart H. This provision does not affect or reopen any of the requirements for regulated substances established under the AIM Act that are codified at 40 CFR part 84, subpart A. The requirements codified at 40 CFR part 84, subpart A are outside the scope of this rulemaking, and to the extent the comment pertains to them, it requires no further response.	

#	Section 5.0 State Authorization Issues
0136	The Subcommittee does not have specific comments on the proposed RCRA refrigerants recycling standards. Our comments focus on the Hazardous and Solid Waste Amendments (HSWA) authority under which EPA is proposing to promulgate the standards. We read the proposed standards as being very similar to the optional and less stringent provisions of the transfer-based exclusion for hazardous secondary materials in the 2018 Definition of Solid Waste (DSW) rule. By adopting the ignitable spent refrigerant recycling standards under HSWA authority, the provisions become immediately effective in States that chose not to adopt the optional DSW provisions. The proposed rule will make a change to very small quantity generator (VSQG) requirements that mandates spent refrigerants regulated by the proposed alternative standards be recovered / recycled using equipment that is certified by 40 CFR 82.158 and at a facility certified via 40 CFR 82.164. EPA indicates that the change makes the proposed rule more stringent and would therefore be a HSWA rule, which would consequently make the standards automatically applicable on the effective date in all States. However, EPA also indicates that the rule "reduces the applicability of many RCRA requirements" and "VSQGs would experience no additional burden since under the CAA [Clean Air Act] section 608 rules, all reclaimers…must meet EPA's certification requirements in 40 CFR 82.164". When viewed through this lens, the proposed rule is not more stringent, it simply reinforces regulatory requirements already applicable to the reclamation of used / spent refrigerants by the CAA and reduces RCRA requirements. We observe it accomplishes this reduction of RCRA requirements by, more or less, mandating portions of the 2018 DSW rule that, until now, were optional. Page 2 of 2 The Subcommittee does not have an issue with the proposed management of the waste stream. Our concern is with standards being considered more stringent when in effect they are not, with the outcome being the standards would become immediately effective in all States. The history of the DSW rule is one of varying State views towards it. As a result, it has been left up to States to adopt or modify it in ways that meet their individual needs.
EPA Response: EPA disagrees with this comment. The final RCRA alternative standards are being promulgated under the authority of HSWA, and are more stringent than the existing federal regulations. Thus, the standards will be applicable on the rule's effective date in all states and will be implemented and enforced by EPA until the states receive authorization. This action adds a new subpart Q to 40 CFR part 266 Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities, and it is being finalized under the authority of HSWA due to its purpose of reducing air emissions from the management of ignitable spent refrigerants, in accordance with EPA's mandate to control air emissions from hazardous waste management, as may be necessary to protect human health and the environment, per RCRA section 3004(n), which was promulgated under HSWA. In addition, the changes to the Very Small Quantity Generator Regulations in 40 CFR 262.14 are being promulgated under RCRA section 3001(d)(4), also a HSWA provision. The final alternative standard establishes a "cradle-to-cradle" management system for ignitable spent refrigerants being recycled for reuse and includes requirements that are more stringent than the current applicable RCRA recycling requirements in 40 CFR 261.6(c), which exempts the recycling process itself from RCRA regulation. This final management system includes the	

requirement that refrigerant be recovered and/or recycled for reuse on-site using equipment that is certified for that type of refrigerant and appliance under 40 CFR 82.36 or 82.158, and that the recovered refrigerant sent off-site to be recycled for reuse at a facility certified by EPA under 40 CFR 82.164. In addition, the revisions to the VSQG regulations in 40 CFR 262.14 limit where VSQGs can send ignitable spent refrigerant for recycling for reuse to facilities that meet EPA's certification requirements in 40 CFR 82.164 and are more stringent than the current standard. These certifications involve a number of requirements for reclamation that are more stringent than those under the RCRA hazardous waste program, including an explicit limit of no more than 1.5 percent of the refrigerant released during the reclamation process (see 40 CFR 82.164(a)(3)). In addition, these certified reclaimers must follow recordkeeping and reporting requirements, per 40 CFR 82.164(d) including (1) maintaining records of the names and addresses of persons sending them material for reclamation and the quantity of the material (the combined mass of refrigerant and contaminants) sent to them for reclamation, and (2) reporting annually the quantity of material sent to them for reclamation by refrigerant type, the mass of refrigerant reclaimed by refrigerant type, and the mass of waste products. Finally, EPA-certified refrigerant reclaimers must verify that each batch of reclaimed refrigerant meets the specifications in the regulations (40 CFR 82.164(a)(2)), which helps ensure that the reclamation process is legitimate recycling under the RCRA regulations. These alternative standards are designed to function as system that is better tailored to the reclamation of ignitable spent refrigerants than the RCRA requirements in 40 CFR 262-270, and when considered as a whole are more stringent when compared to the previously applicable RCRA recycling requirements. Because the revisions in this rule are considered to be more stringent than the existing federal requirements, authorized states must modify their programs to adopt regulations equivalent to the provisions contained in this final rule.

Under RCRA section 3006, states may be more stringent than the federal program. Thus, states may choose to include additional requirements for ignitable spent refrigerants being recycled for reuse when they modify their program in response to this action. However, those modification must include, at minimum, requirements that are equivalent to those being finalized in this action.

#	Section 6.0 Venting of Ignitable Spent Refrigerants Under RCRA
0082	Resource Conservation and Recovery Act (RCRA) – The EPA is proposing language changes in the RCRA regulations that will allow ignitable spent refrigerants recycled for reuse to be managed as recyclable materials. It is recommended the EPA take this opportunity to revise the RCRA regulations to allow for non-households to take advantage of the exemption from venting prohibition for flammable refrigerants listed under 40 CFR 82.154(a)(1)
0129	Flammable Refrigerant handling will impact maintenance and operations; however, gaps in the existing proposed rulemaking related to the venting ban exist. The EPA suggests that if a user vents a refrigerant listed as an RCRA substance, i.e., ignitable refrigerant, then the EPA has no authority; however, if it is recovered, then it is RCRA controlled, we ask the EPA to

	reconsider the wording and clarify the obligation when you publish the final rule. a. As written, bypassing the EPA's responsibility/suggestion/guidance for recovery is possible since venting of this kind is not specified. (specifically referring to the commercial sector) If venting is allowed, please define the thresholds and limits. The marketplace will need to know what is allowable for venting. Is it a blend that contains a portion of flammable or ignitable material?
158	ISRI commented on subsequent EPA's proposals involving flammable refrigerants and exemptions to the venting prohibition at § 82.154(a). ISRI noted while these CAA Title VI exemptions to the venting prohibition allow release to the atmosphere of certain HC refrigerants, the RCRA Subtitle C regulations may consider such releases to be disposal of hazardous waste, besides the original generation of hazardous waste via recovery from equipment. (Authorized state CAA regulations may impose additional restrictions on releases to the atmosphere of HC refrigerants as volatile organic compounds.) While EPA has acknowledged this hazardous waste issue, EPA has also rationalized that the household waste exclusion from hazardous waste at § 261.4(b)(1) makes this issue somewhat moot. While § 261.4(b)(1) does apply at all times to refrigerant-using equipment, including refrigerant, from actual households and equivalent residential settings, it does not apply to other types of (i.e., non-"household") small appliances (e.g., vending machines) or even a "household" refrigerator/freezer that came from, say, a staff kitchen in EPA Headquarters. "Household" does not mean the same thing between the RCRA Subtitle C and the CAA Title VI regulations, and not all CAA "small appliances" are RCRA "household" appliances (RCRA). MVACs and MVAC-like appliances are neither "household" nor "small" appliances under either set of regulations. In practice, § 261.4(b)(1) is not particularly useful to recycling of end-of-life (EOL) small appliances and vehicles under § 82.155 for two reasons: the scope of § 261.4(b)(1) is limited (e.g., it does not apply to MVACs); and proving the provenance of small appliances as actual RCRA "household" appliances is exceedingly difficult in complex supply chains. How is a recycler supposed to distinguish which EOL refrigerator/freezer delivered for recycling by a big-box store's appliance trade-in recycling program (under contract per § 82.155(b)(2)) came from the staff kitchen of EPA Headquarters or another business vs. from an actual household?

EPA Response: Section 608 of the Clean Air Act prohibits individuals from knowingly venting or otherwise knowingly releasing or disposing of ozone-depleting substances or their substitutes while maintaining, servicing, repairing, or disposing of air-conditioning or refrigeration equipment. EPA's implementing regulations in 40 CFR 82.154(a) include exemptions for releases of substitute refrigerants in particular applications, where EPA has determined that such venting, release, or disposal does not pose a threat to the environment. For purposes of RCRA, and as EPA has previously stated (81 FR 86800, 88 FR 72274), EPA considers incidental releases of spent refrigerant that occur during the maintenance, service, and repair of appliances subject to CAA section 608 generally not to be disposal of a hazardous waste under RCRA. However, even if an exemption from the venting prohibition applies under 40 CFR 82.154(a), ignitable spent refrigerant from commercial and industrial appliances would be classified as hazardous waste and would need to be managed under the applicable RCRA regulations when recovered (i.e., removed from an appliance and stored in an external container) or disposed of.

#	Section 7.0 Technical Corrections and Clarifications
0091	Due to inconsistencies and out-of-date references/language found in part 261, subpart M and the beginning paragraphs of §§261.400, 261.410, 261.411, and 261.420, we recommend the following changes: • "Subpart M—Emergency Preparedness and Response for Management of Excluded Hazardous Secondary Materials and Ignitable Spent Refrigerants"
EPA response: EPA disagrees with this comment. Because spent refrigerants are a type of hazardous secondary material it is unnecessary to revise the title of this Subpart to include them.	
0091	Under §261.400 Applicability, write: • "The requirements of this subpart apply to entities managing hazardous secondary materials excluded under §261.4(a)(23), (a)(24), and/or for ignitable spent refrigerants, regulated under part 266, subpart Q, where such materials are generated or accumulated on site."
0091	Continuing with §261.400: • "(a) Generators, reclaimers, and intermediate facilities managing hazardous secondary materials under §261.4(a)(23) and/or (a)(24) that accumulate 6000kg or less of hazardous secondary material at any time must comply with §§261.410 and 261.411." • "(b) Generators, reclaimers, and intermediate facilities managing hazardous secondary materials under §261.4(a)(23) and/or (a)(24) that accumulate more than 6000kg of hazardous secondary material at any time must comply with §§261.410 and 261.420." • "(c) Entities that manage ignitable spent refrigerants under part 266, subpart Q must comply with §§261.410 and 261.420." Note: The new language in (c) is necessary as part 261, subpart M applies to not only the recycler but also the generator of the ignitable solvent [sic], as mentioned in the §261.400 introductory paragraph. A similar addition will be seen in §266.602 below. §261.410(a) should read: • "*Maintenance and operation of facility.* Facilities generating or accumulating hazardous secondary materials and/or ignitable spent refrigerants regulated under part 266, subpart Q must be maintained and operated..." followed by the rest of the existing paragraph (a). The §261.420 title should read: • "Contingency planning and emergency procedures for facilities generating or accumulating more than 6000kg of hazardous secondary material and for entities managing ignitable spent refrigerants under part 266, subpart Q. Change the §261.420 introductory paragraph to read:

	• "Generators, reclaimers, and intermediate facilities managing hazardous secondary materials under §261.4(a)(23) and/or (a)(24) that accumulates more than 6000kg of hazardous secondary material, and entities managing ignitable spent refrigerants under part 266, subpart Q must comply with the following requirements:" §261.420(a) should read: • "*Purpose and implementation or contingency plan.* (1) Each generator, reclaimer, and intermediate facility managing hazardous secondary materials under §261.4(a)(23) and/or (a)(24) that accumulates more than 6000kg of hazardous secondary material, and entities managing ignitable spent refrigerants under part 266, subpart Q must have a contingency plan for his facility…" followed by the rest of the existing paragraph (a). A similar change is necessary in §261.420(b)(2), which should read: • If the generator, reclaimer, or intermediate facility managing hazardous secondary materials under §261.4(a)(23) and/or (a)(24) accumulating more than 6000kg of hazardous secondary material, or the entity managing ignitable spent refrigerants under part 266, subpart Q already prepared a Spill Prevention, Control, and Countermeasures (SPCC) Plan in accordance with part 112 of this chapter,…" followed by the rest of the existing paragraph (b)(2).
0091	Since part 261 subpart M compliance is required for the "generators" or the persons who recycle their ignitable spent solvents [sic], such a provision should be added to §266.602. We recommend adding the language at §266.602(a)(2) and bumping the proposed (a)(2) to (a)(3) to match the order found in §266.602(b). §266.602(a)(2) and (3) should therefore read: • "(2) Meet the emergency preparedness and response requirements of 40 CFR part 261, subpart M; and (3) Not speculatively accumulate the ignitable spent refrigerant per §261.1(c)."
EPA response: EPA disagrees with these comments. These suggested changes are based on the premise that 40 CFR part 261 subpart M would apply to not only the recycler but also the generator of the ignitable refrigerant, which is not the case. As explained in the proposed rule, EPA proposed that facilities receiving ignitable spent refrigerants from other parties for recycling for reuse be subject to this additional emergency preparedness requirement because these third-party recyclers would be receiving ignitable spent refrigerant from multiple sources, and are likely to store greater volumes for longer time periods than companies that recycle for reuse for their own equipment or as part of an MVAC refrigerant recovery and recycling system in compliance with 40 CFR part 82, subpart B. (88 FR 72276). EPA has revised the applicability language in 40 CFR 261.400 to make this clearer.	
0091	Note: The EPA's proposed language of "alternative standards" is removed since the agency's language in §266.600(b) and at 88 *FR* 72275 make clear subpart Q applies in lieu of the main hazardous waste program and is not an "option." Removing "alternative" makes it clear the refrigerants applicable to part 266, subpart Q must be managed under that standard. Compare this approach to a "true" alternative, such as the alternative treatment standards for lab packs in §268.42(c) vs. managing lab packs under the §268.40 treatment standards.

<table>
<tr><td colspan="2">EPA response: EPA’s use of the word “alternative” in describing the new RCRA standards for ignitable spent refrigerants is meant to explain that these are different hazardous waste requirements than those found in 40 CFR part 262 – 268, not that they are optional. Clarifying language has been added to the preamble to the final rule and the word “alternative” in the regulatory text has been removed.</td></tr>
<tr><td>0091</td><td>We want to point out other corrective language changes can be made throughout part 261, subpart M due to the hazardous secondary materials exclusions of 261.4(a)(23) and (24), changing from 2015 to 2018 but that is beyond the scope of this letter which is focused on the ignitable spent refrigerant proposal.</td></tr>
<tr><td colspan="2">EPA response: EPA agrees these changes are beyond the scope of this rule.</td></tr>
<tr><td>0091</td><td>We recommend changing the conjunctions for clarity in the proposed §262.14(a)(5)(vi) changes to read:
“(A) Beneficially uses or reuses, or legitimately recycles or reclaims its waste.
(B) Treats its waste prior to beneficial use or reuse, or legitimate recycling or reclamation; or
(C) For ignitable spent refrigerants regulated under part 266, subpart Q, meets the requirements of that subpart;”</td></tr>
<tr><td colspan="2">EPA response: EPA has revised the regulatory language to be clearer. Specific, §262.14(a)(5)(vi) has been revised to read:
(A)(1) Beneficially uses or reuses, or legitimately recycles or reclaims its waste, or
(2) Treats its waste prior to beneficial use or reuse, or legitimate recycling or reclamation; and
(B) For ignitable spent refrigerants regulated under part 266, subpart Q, meets the requirements of that subpart.</td></tr>
<tr><td>0091</td><td>§266.600 should be rewritten to improve clarity of applicability and consistency with other exemptions referenced in §261.6(a). While we feel §266.600(a) is written correctly, we recommend changing paragraphs (b) and(c) to read:
“(b) The requirements of this subpart operate in lieu of parts 262 through 270 and 124 and apply only to ignitable spent refrigerants, as defined in §266.601, that meet the definition of lower flammability spent refrigerant, and are being recycled for reuse in the U.S.
(c) These requirements do not apply to ignitable spent refrigerants that do not meet the definition of lower flammability spent refrigerant. Ignitable spent refrigerants not subject to this subpart are subject to all applicable requirements of parts 262 through 270 and 124 when recovered (i.e., removed from an appliance and stored in an external container) and/or disposed of.”</td></tr>
<tr><td colspan="2">EPA response: EPA has revised this section to improve clarity.</td></tr>
<tr><td>0091</td><td>A formal definition of “ignitable spent refrigerant” in §266.601 is necessary as it is what is actually being regulated and helps clarify the language in §266.600. We recommend the definition read:
“Ignitable spent refrigerant means a spent refrigerant that is a hazardous waste only because it exhibits the characteristic of ignitability per 261.21, does not exhibit another characteristic of part 261, subpart C, and is not listed per part 261, subpart D.”</td></tr>
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EPA response: EPA has added a definition of "ignitable spent refrigerant" to 40 CFR 266.601 consistent with the preamble discussion in the proposal.	
0091	The title of §266.602 should use the word "persons" instead of "facilities" since, per §270.1(c)(2)(xi), these entities do not need a RCRA permit. The title of §266.602 should read: • "§266.602 Standards for persons that recycle ignitable spent refrigerant for reuse under this subpart."
EPA response: EPA has made this suggested change**.**	
0152	EPA's preamble discussion of the proposed RCRA requirements regarding the use of certified recovery and/or recycling equipment and certified reclaimers, and the proposed regulatory text implementing these requirements are unclear and inconsistent. In the preamble discussion, there appears to be lack of a clear command for persons recovering/recycling ignitable spent refrigerants for reuse to use certified recovery/recycling equipment, but we believe that the inserted language below reflects EPA's intent. The specific standards EPA is proposing for ignitable spent refrigerant being recycled for reuse either on-site for further use in equipment of the same owner, or by the owner of the recovery equipment in compliance with MVAC standards in 40 CFR part 82, subpart B, are (1) the ignitable spent refrigerants that are recovered (i.e., removed from an appliance and stored in an external container) and/or recycled for reuse [must be recovered and/or recycled] using equipment that is certified for that type of refrigerant under 40 CFR 82.36 or 40 CFR 82.158; and (2) the ignitable spent refrigerants are not speculatively accumulated as defined in 40 CFR 261.1(c).
EPA response: EPA has revised the regulatory language to make this clearer.	
0152	The proposed regulatory language, 40 CFR §266.602, adds confusion as, among other things, it switches from the "facilities receiving" approach used in the preamble to a "persons receiving" approach. In order to more clearly express what we believe to be EPA's intent with respect to these proposed RCRA requirements, and rationalize the proposed regulatory text with the preamble discussion, we suggest the following revisions to the proposed language in 40 CFR 266.602: §266.602 Standards for facilities that recover and/or recycle ignitable spent refrigerant for reuse under this subpart. (a) Persons who recover (i.e., remove from an appliance and store in an external container) and/or recycle ignitable spent refrigerants for reuse either on-site for further use in equipment of the same owner, or for use by the owner of the recovery equipment as part of an MVAC refrigerant recovery and recycling system in compliance with motor vehicle air conditioner (MVAC) standards in 40 CFR part 82, subpart B, must: (1) Recover (i.e., remove from an appliance and store in an external container) and/or recycle for reuse the ignitable spent refrigerant using Use recovery and/or recycling equipment that is certified for that type of refrigerant and appliance under §82.36 and 82.158; and (2) Not speculatively accumulate the ignitable spent refrigerant per §261.1(c). (b) Persons receiving ignitable spent refrigerant from another person off-site to be recycled by the recipient for reuse under this subpart must: (1) Maintain reclaimer certification by EPA under §82.164, (2) Meet the emergency preparedness and response requirements of 40 CFR part 261, subpart M; and (3) Not speculatively accumulate the ignitable spent refrigerant per §261.1(c).
EPA response: EPA has revised the regulatory language to make this clearer.	

158	E. Proposed § 266.602 Must Be Revised Because It Covers Certain Situations in which Ignitable Spent Refrigerants Are Not Solid Waste When Recycled for Reuse. Notwithstanding the comments in Section II.D. above, proposed § 266.602, Standards for facilities that recycle ignitable spent refrigerant for reuse under this subpart, applies to people in two basic situations: a) people who recycle for reuse on-site ignitable spent refrigerant generated on-site, regulated under § 266.602(a); and b) people who receive ignitable spent refrigerant from off-site to be recycled for reuse, regulated under § 266.602(b). 22 See, for instance, https://www.sigmaaldrich.com/US/en/technical-documents/technical-article/chemistry-andsynthesis/acid-base-chart. EPA-HQ-OAR-2022-0606 -10- December 18, 2023 The first situation seems to involve ignitable spent refrigerant that remains in the control of the generator through recycling for reuse, all on-site. The second situation does not (and is dropped from further discussion). A spent material that remains in the control of the generator—including that it has been properly handled so that it does not endanger human health or the environment—is not necessarily discarded. If a spent material is not discarded, it is neither solid waste nor hazardous waste and exists outside RCRA Subtitle C authority. However, what happens to the spent material in the control of the generator does matter respecting whether it will become solid waste or hazardous waste. As noted above, the first situation includes recycling for reuse of ignitable spent refrigerant. As noted in the preamble of the Proposal, the proposed definition of "recycle for reuse" at § 266.601(b) includes various processes for removing contamination from spent refrigerant so that it can be reused. Some of these processes appear to meet the RCRA Subtitle C definition of "reclaimed" at § 261.1(c)(4). The process described under § 82.34(d)(1)(ii) for recovering and recycling of refrigerant does not appear to meet the RCRA Subtitle C definition of "reclaimed" at § 261.1(c)(4). The case of recovery and recycling under § 82.34(d)(1)(ii) is a specific circumstance listed in the first situation under proposed § 266.602(a). To the extent that § 82.34(d)(1)(ii) involves recycling of ignitable spent refrigerant without reclamation per § 261.1(c)(4), the recycled ignitable spent refrigerant is covered by the exclusion at § 261.2(e)(1)(ii) for "[m]aterials that are not solid waste when recycled" by being "[u]sed or reused as effective substitutes for commercial products". Because such recycled ignitable spent refrigerant is not solid waste, it is not hazardous waste and outside RCRA Subtitle C authority. This situation should not be included in § 266.602(a), and neither should any other situation for recycling an ignitable spent refrigerant that involves a process covered by the proposed definition of "recycle for reuse" that does not involve reclamation per § 261.1(c)(4). This conclusion is consistent with an earlier EPA statement that "these [flammable] refrigerants may be subject to regulation as hazardous waste, with the exception of refrigerants that are directly reused." The above recycling in the first situation without reclamation under the control of the generator may be tantamount to "direct reuse". 23 81 Fed. Reg. 82309-82310, November 18, 2016; EPA-HQ-OAR-2015-0453-0125. EPA-HQ-OAR-2022-0606 -11- December 18, 2023 In the alternative, when recycling of spent refrigerant does involve reclamation, such spent refrigerant would be hazardous waste per § 261.2(c)(3) and thus appropriate to include in § 266.602(a). EPA must review proposed § 266.602(a) to remove from its scope any recycling for reuse situations that involve ignitable spent refrigerants covered by the exclusion from solid waste at § 261.2(e)(1)(ii).
EPA response: EPA agrees that ignitable spent refrigerant that can be legitimately reused directly for its intended purpose without processing is not a solid waste under 40 CFR 261.2, and would not be subject to the new RCRA alternative standards. EPA has added a definition of "ignitable spent refrigerant" to make it clear that refrigerants that can be reused in such a way would not be included. EPA disagrees that the	

definition of "reclaimed" at § 261.1(c)(4) would not include "various processes for removing contamination from spent refrigerant so that it can be reused". The RCRA regulations at 40 CFR 261.1(c)(4) say that "a material is "reclaimed" if it is processed to recover a usable product, or if it is regenerated." Any process that removes contamination so that a refrigerant can be reused would fall under this RCRA provision.	
0152	First, the "off-site" concept would appear to potentially trigger applicability to activities conducted solely by a single person or entity when recovered ignitable spent refrigerants are transferred between commonly owned/operated sites. But, so long as such recovered refrigerants will be used in equipment owned by the same owner as the equipment from which the refrigerants were recovered, it should not make a difference that the refrigerant was recovered at one site, recycled at another site and then reused at another site owned/operated by the same person/entity. EPA needs to clarify that the proposed requirements for recycling facilities do not apply to a single person/entity transferring recovered refrigerants between sites owned or operated by the same person/entity or to the recycling of those recovered refrigerants at any of those sites. Instead, these requirements should only apply to "third party recyclers" as indicated at page 22776 of the preamble; these requirements should not apply to "in-house" recovery/recycling when the refrigerant will be reused by the same person/entity
EPA response: EPA has revised the language to reflect that recycling ignitable spent refrigerant for reuse in equipment owned by the same owner from which the refrigerants were recovered would be covered under the requirements in 40 CFR 266.602(a).	

#	Section 8.0 Request for New Hazardous Waste Exemption for Flammable Refrigerants
158	To eliminate this hazardous waste issue and the associated regulatory uncertainty regarding flammable refrigerants, especially those exempt from the venting prohibition, ISRI suggested via those comments that the RCRA Subtitle C regulations be revised to include an exclusion from hazardous waste specific to these situations. ISRI's suggestions included a request that EPA create a new exclusion for flammable refrigerants that is analogous to the hazardous waste exclusion at § 261.4(b)(12) for certain used CFC refrigerant that is reclaimed. EPA has denied or ignored ISRI (i.e., the commenter) every time (**emphasis** added): "A commenter representing recyclers of automobiles and scrap metal expressed concern about the regulatory burden and costs that automotive recyclers are likely to incur if they must manage flammable refrigerants that are regulated as hazardous waste under EPA's regulations implementing the Resource Conservation and Recovery Act (RCRA). The same commenter also suggests that the RCRA subtitle C regulations would need to be changed to alleviate the hazardous-waste management requirements for handling HFO–1234yf. … We believe the potential burden of complying with RCRA regulations placed on those recycling or recovering a substitute is generally not pertinent to a decision of whether HFO–1234yf should be found acceptable under SNAP. … **To the extent the costs referred to by the commenter are already imposed under RCRA, they would not be new costs, but costs associated with the relevant RCRA regulations. Moreover, under this SNAP final rule, EPA is not requiring the use of HFO–1234yf, and thus the costs associated with its use are not due to enforceable regulatory requirements under SNAP.** The commenter suggests that EPA could create a new exclusion from hazardous waste at 40 CFR 261.4(b) for an acceptable ignitable refrigerant substitute, or determine that an acceptable ignitable refrigerant is equivalent to household waste under 40 CFR 261.4(b)(1). **… The commenter's request to modify the hazardous waste regulations is beyond the scope of this rulemaking, since it focuses on Sections 608 and 612 of the CAA.** One commenter requested that EPA exclude hydrocarbon refrigerants that are vented from the definition of hazardous waste. … The commenter notes that a household-type appliance may also originate from institutional and commercial settings and therefore would not qualify for the household waste exclusion under RCRA. … EPA responds that these refrigerants may be subject to regulation as hazardous waste, with the exception of refrigerants that are directly reused. **The Agency did not propose to amend the regulations issued under RCRA in the proposal to this final action and has not undertaken the analysis to do so at this time. This comment is also outside the scope of this rulemaking, which relates to regulations under section 608 of the CAA, not to regulations under RCRA."** Consistent with and maybe in response to this, EPA has pre-emptively cut-off discussion about such a RCRA Subtitle C exclusion in this Proposal: "EPA is not reopening the original CFC refrigerant recycling exclusion and is not requesting comment on 40 CFR 261.4(b)(12). Any comments received on the CFC refrigerant recycling exclusion will be considered out of scope of this rulemaking." It is mystifying why EPA has been so adamant about not discussing such an exclusion (for more than 13 years). The fact that the Proposal includes a new Subpart Q, Ignitable Spent Refrigerants Recycled for Reuse, under 40 CFR Part 266 of the RCRA Subtitle C regulations seems incidental.

EPA response: The commenter is correct that EPA did not reopen or request comment on the CFC refrigerant recycling exclusion at 40 CFR 261.4(b)(12). EPA also did not propose or request comment on adding a new hazardous waste exemption for flammable refrigerants to 40 CFR 261.4(b) and comments to that effect are outside the scope of this RCRA rulemaking, which is focused on the new RCRA alternative standards proposed for ignitable spent refrigerants at 40 CFR part 266 Subpart Q.	

Appendix – List of Commenters by Comment ID Number

Comment ID Number	Comment Submitted by
EPA-HQ-OAR-2022-0606-0082	Savannah River Nuclear Solutions (SRNS)
EPA-HQ-OAR-2022-0606-0084	American Refrigerants
EPA-HQ-OAR-2022-0606-0085	The Chemours Company
EPA-HQ-OAR-2022-0606-0091	Lyons Educational Services, LLC
EPA-HQ-OAR-2022-0606-0102	Golden Refrigerant
EPA-HQ-OAR-2022-0606-0109	A-Gas
EPA-HQ-OAR-2022-0606-0110	Mexichem Fluor Inc. (d/b/a Koura)
EPA-HQ-OAR-2022-0606-0111	FluoroFusion Specialty Chemicals, Inc.
EPA-HQ-OAR-2022-0606-0113	National Refrigerants, Inc.
EPA-HQ-OAR-2022-0606-0121	Air-Conditioning, Heating and Refrigeration Institute (AHRI) and the Alliance for Responsible Atmospheric Policy
EPA-HQ-OAR-2022-0606-0129	Trakref
EPA-HQ-OAR-2022-0606-0136	Association of State and Territorial Solid Waste Management Officials (ASTSWMO)
EPA-HQ-OAR-2022-0606-0139	California Air Resources Board
EPA-HQ-OAR-2022-0606-0145	Trane Technologies
EPA-HQ-OAR-2022-0606-0152	National Environmental Development Association's Clean Air Project (NEDA/CAP)
EPA-HQ-OAR-2022-0606-0158	Institute of Scrap Recycling Industries, Inc. (ISRI)
EPA-HQ-OAR-2022-0606-0159	Hudson Technologies, Inc.