

U.S. NUCLEAR REGULATORY COMMISSION

REGULATORY GUIDE 3.7, REVISION 1



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MONITORING OF COMBUSTIBLE GASES AND VAPORS IN PLUTONIUM PROCESSING AND FUEL FABRICATION PLANTS

A. INTRODUCTION

Purpose

This regulatory guide (RG) describes a program acceptable to the U.S. Nuclear Regulatory Commission (NRC) staff for complying with the NRC's regulations with regard to protecting against the possibility of the formation of flammable mixtures with combustible gases and vapors. Such a program is needed when combustible gases and solvents are used within the confinement barriers of a plutonium processing and fuel fabrication plant. The presence of such a flammable mixture within the multiple confinement barriers of the plant could result in a fire or explosion that might breach one or more of the confinement barriers and allow radioactive material to be dispersed within regions of the plant and possibly the environment.

Applicability

This RG applies to applicants for a license to possess and use special nuclear material in a plutonium processing and fuel fabrication plant as defined in Title 10 of the *Code of Federal Regulations* (10 CFR) 70.4, "Definitions" (Ref. 1). Each applicant must fulfill the provisions of 10 CFR 70.22, "Requirements for the approval of applications."

Applicable Regulations

- 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material," provides regulations for licensing for the possession and use of special nuclear materials.
 - 10 CFR 70.4 defines a "plutonium processing and fuel fabrication plant" as follows:

a plant in which the following operations or activities are conducted:
(1) Operations for manufacture of reactor fuel containing plutonium including any of the following: (i) Preparation of fuel material; (ii) formation of fuel material into desired shapes; (iii) application of protective cladding; (iv) recovery

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Electronic copies of this RG, previous versions of RGs, and other recently issued guides are also available through the NRC's public website in the NRC Library at <https://www.nrc.gov/reading-rm/doc-collections/reg-guides/index.html> under Document Collections, in Regulatory Guides. This RG is also available through the NRC's Agencywide Documents Access and Management System (ADAMS) at <https://www.nrc.gov/reading-rm/adams.html>, under ADAMS Accession Number (No.) ML24162A095.

of scrap material; and (v) storage associated with such operations; or
(2) Research and development activities involving any of the operations described in paragraph (1) of this definition except for research and development activities utilizing unsubstantial amounts of plutonium.

- 10 CFR 70.22(a)(7) and (8) require that the applicant's proposed equipment and facilities and proposed procedures be adequate to protect health and minimize danger to life or property.

Related Guidance

- NUREG-1718, "Standard Review Plan for the Review of an Application for a Mixed Oxide (MOX) Fuel Fabrication Facility," issued August 2000 (Ref. 2), discusses the construction approval review specifically related to plutonium processing and fuel fabrication and provides guidance for NRC staff reviewers in the Office of Nuclear Material Safety and Safeguards who will perform safety, safeguards, and environmental reviews of the anticipated application for a license to possess and use special nuclear material for a mixed oxide fuel fabrication facility under 10 CFR Part 70.
- National Fire Protection Association (NFPA), Standard 801, "Standard for Fire Protection for Facilities Handling Radioactive Materials," (Ref. 3), discusses the applicable standards to protect the safety of the public, facility personnel, and the environment from the effects of fire or explosions on radiological and other hazardous materials at all facilities handling radioactive materials, except nuclear reactors.

Purpose of Regulatory Guides

The NRC issues RGs to describe methods that are acceptable to the staff for implementing specific parts of the agency's regulations, to explain techniques that the staff uses in evaluating specific issues or postulated events, and to describe information that the staff needs in its review of applications for permits and licenses. Regulatory guides are not NRC regulations and compliance with them is not required. Methods and solutions that differ from those set forth in RGs are acceptable if supported by a basis for the issuance or continuance of a permit or license by the Commission.

Paperwork Reduction Act

This RG provides voluntary guidance for implementing the mandatory information collections in 10 CFR Part 70 that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et seq.). These information collections were approved by the Office of Management and Budget (OMB), under control number 3150-0009. Send comments regarding this information collection to the FOIA, Library, and Information Collections Branch, Office of the Chief Information Officer, Mail Stop: T6-A10M, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or to the OMB reviewer at: OMB Office of Information and Regulatory Affairs, (3150-0009), Attn: Desk Officer for the Nuclear Regulatory Commission, 725 17th Street, NW, Washington, DC, 20503.

Public Protection Notification

The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless the document requesting or requiring the collection displays a currently valid OMB control number.

B. DISCUSSION

Reason for Revision

The NRC is revising RG 3.7 to incorporate editorial changes and the current format for RGs. These changes were intended to improve clarity and did not alter the staff regulatory guidance.

Background

Within a plutonium processing and fuel fabrication plant, a postulated fire or explosion is an accident that can furnish sufficient energy for the release and dispersal of radioactive material from the confinement barriers to the regions occupied by working personnel and, depending upon the severity of the accident, to the environment. Therefore, conditions that can lead to these hazardous events must be precluded. One such event is the uncontrolled or undetected formation of a flammable mixture of a combustible gas or vapor and an oxidant followed by its deflagration or detonation.

Combustible gases and vapors and their limits of flammability in various oxidizing atmospheres have been studied by the Bureau of Mines (Refs. 4 and 5). Flammability has been found to be a function of the type of combustible gas, oxidant concentration, temperature, humidity, vessel characteristics, and direction of flame propagation, among other things. Within the confinement barriers of a plutonium processing and fuel fabrication plant, flammable mixtures must be precluded, and therefore the maximum allowable concentration of any combustible gas or vapor in a mixture should always be below the lower limit of flammability as given for that particular mixture.

Some common sources of combustible gases and vapors that have led to fires and explosions within confinement barriers have been (1) solvents or coolants used in chemical processing, surface finishing, or equipment maintenance, (2) reducing atmospheres used in conversion and sintering furnaces, and (3) decomposition products formed during waste incineration and chemical processing. Measures have been developed to prevent the recurrence of flammability conditions and have been based on one or more of the following concepts: (1) prohibiting or restricting the use of combustible material, (2) inert gas purging within the confinement barriers where combustible gases or vapors are expected, thus reducing or eliminating the oxidant content, or increasing the air flow within these confinement barriers, thus diluting the combustible concentration below the lower limit for flammability, and (3) establishing other procedural changes based upon the results of the accident investigation.

While this arrangement has for the most part been effective in preventing the recurrence of fires and explosions for specific processes within an individual facility, such procedures usually have been initiated or emphasized only after an accident and may suffer with time from relaxation of vigilance, process modifications, and the formation of unexpected combustible products. The monitoring and alarm system for combustible gases and vapors discussed in this RG is expected to contribute to the safe operation of the plant in many ways, especially in the following aspects:

- An initial fire or explosion accident is unlikely to happen because an alarm will indicate when the flammable limit is being approached.
- The need for administrative involvement should be minimal because the system can provide continuous automatic surveillance.
- Unexpected combustible products will have a high probability of detection.

Consideration of International Standards

The International Atomic Energy Agency (IAEA) works with member states and other partners to promote the safe, secure, and peaceful use of nuclear technologies. The IAEA develops Safety Requirements and Safety Guides for protecting people and the environment from harmful effects of ionizing radiation. This system of safety fundamentals, safety requirements, safety guides, and other relevant reports, reflects an international perspective on what constitutes a high level of safety. To inform its development of this RG, the NRC considered IAEA Safety Requirements and Safety Guides pursuant to the Commission's International Policy Statement (Ref. 6) and Management Directive and Handbook 6.6, "Regulatory Guides" (Ref. 7).

The NRC staff did not identify any IAEA Safety Requirements or Guides with information related to the topic of this RG.

C. STAFF REGULATORY GUIDANCE

The staff is providing the following regulatory guidance:

1. All processes and plant operations carried out in or associated with the confinement barriers of a plutonium processing plant should be evaluated as potential sources of combustible solvents, gases, or vapors.
2. Where sources of combustible solvents, gases, or vapors can be identified or postulated under normal or abnormal conditions, the formation of a flammable or explosive mixture within the confinement barriers should be precluded by establishing suitable process parameters and plant operating procedures.
3. Assurance that the established processing and operating procedures are maintaining safe conditions should be provided by suitable continuous monitoring systems appropriately placed within those confinement barriers that were identified in Regulatory Position C.1. These systems should give an audible and visual local alarm indication to operating personnel when the prescribed safe limits for combustible gas and vapor mixtures have been achieved or exceeded.
4. The procedure for remedial action to be taken in the event of an alarm signal should be established.
5. The absence of an evident ignition source within those confinement barriers postulated to contain combustible gases, solvents, or vapors does not relieve the requirement for a monitoring and alarm system.
6. The monitoring and alarm system itself should not introduce an ignition source and should not affect the confinement integrity.
7. The monitoring and alarm system should be designed for in-place calibration and testing.

D. IMPLEMENTATION

The NRC staff may use this regulatory guide as a reference in its regulatory processes, such as licensing, inspection, or enforcement. However, the NRC staff does not intend to use the guidance in this regulatory guide to support NRC staff actions in a manner that would constitute backfitting as that term is defined in 10 CFR 70.76, “Backfitting,” and as described in NRC Management Directive 8.4, “Management of Backfitting, Forward Fitting, Issue Finality, and Information Requests,” (Ref. 8). The staff also does not intend to use the guidance to support NRC staff actions in a manner that constitutes forward fitting as that term is defined and described in Management Directive 8.4. If a licensee believes that the NRC is using this regulatory guide in a manner inconsistent with the discussion in this Implementation section, then the licensee may file a backfitting or forward fitting appeal with the NRC in accordance with the process in Management Directive 8.4.

REFERENCES ¹

1. *U.S. Code of Federal Regulations (CFR)*, “Domestic Licensing of Special Nuclear Material,” Part 70, Chapter I, Title 10, “Energy.”
2. U.S. Nuclear Regulatory Commission (NRC), NUREG-1718, “Standard Review Plan for the Review of an Application for a Mixed Oxide (MOX) Fuel Fabrication Facility,” Washington, DC, August 2000 (ML003741461).
3. National Fire Protection Association (NFPA), Standard 801, “Standard for Fire Protection for Facilities Handling Radioactive Materials,” Quincy, Massachusetts.²
4. Bureau of Mines, Bulletin 503, “Limits of Flammability of Gases and Vapors,” NTIS AD701575, 1952.³
5. Bureau of Mines, Bulletin 627, “Flammability Characteristics of Combustible Gases and Vapors,” NTIS AD701576, 1965.³
6. NRC, “Nuclear Regulatory Commission International Policy Statement,” *Federal Register*, Vol. 79, No. 132, pp. 39415–39418 (79 FR 39415), Washington, DC, July 10, 2014.
7. NRC, Management Directive (MD) 6.6, “Regulatory Guides,” Washington, DC, May 2, 2016 (ML18073A170).
8. NRC, MD 8.4, “Management of Backfitting, Forward Fitting, Issue Finality, and Information Requests,” Washington, DC.

¹ Publicly available NRC published documents are available electronically through the NRC Library on the NRC’s public website at <http://www.nrc.gov/reading-rm/doc-collections/> and through the NRC’s Agencywide Documents Access and Management System (ADAMS) at <http://www.nrc.gov/reading-rm/adams.html>. For problems with ADAMS, contact the Public Document Room staff at 301-415-4737 or (800) 397-4209, or email pdr.resource@nrc.gov. The NRC Public Document Room (PDR), where you may also examine and order copies of publicly available documents, is open by appointment. To make an appointment to visit the PDR, please send an email to pdr.resource@nrc.gov or call 1-800-397-4209 or 301-415-4737, between 8 a.m. and 4 p.m. eastern time (ET), Monday through Friday, except Federal holidays.

² The National Fire Protection Association (NFPA) makes important safety codes and standards available for free online and documents are available at <http://www.nfpa.org/codes-and-standards/document-information-pages>. They may also be purchased by calling NFPA Customer Sales 800.344.3555 or writing NFPA 1 Batterymarch Park, Quincy, Massachusetts 02169-7471.

³ Copies of Bureau of Mines documents are available from the National Technical Information Service (NTIS), 5301 Shawnee Road, Alexandria, Virginia 22312, <https://www.ntis.gov>.