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IDENTICAL LETTERS SENT TO 15 INDIVIDUALS (LIST ATTACHED TO OFFICIAL FILE)

March 31, 1988

A-87-02
II-C-34

NOTICE OF MEETING

The United States Environmental Protection Agency's (EPA) National Air Pollution Control Techniques Advisory Committee (NAPCTAC) will meet on May 18 and 19, 1988, to review the subjects shown on the enclosed agenda. The meeting will be held at the Sheraton Imperial Hotel and Towers in Research Triangle Park, North Carolina.

The NAPCTAC meetings are always open to the public, and you are invited to attend and participate in the discussions. Enclosed are a preliminary draft of the "Review of New Source Performance Standards for Asphalt Processing and Asphalt Roofing Manufacture" and the "Results of the Asphalt Processing and Asphalt Roofing Manufacturing NSPS Review" which will be discussed at the meeting. The meeting was announced in the Federal Register on March 28, but we wanted you to have this information because of your interest in this subject.

In order to properly plan the meeting, it is necessary for me to know prior to the meeting if you plan to make a presentation. Please call Mrs. Mary Jane Clark at (919) 541-5571 by May 10 if you would like to make a presentation. If you do plan a presentation, please bring a copy of it to the meeting for our use in preparing the meeting minutes. If you wish to distribute your presentation to the Committee and staff, 25 copies will be sufficient. Written comments are certainly welcome, and we can schedule a meeting with your association to discuss your comments if you so desire.

For your information, a block of rooms (special rate of $60 a day) is being held at the Sheraton until May 2 for use by those who wish to stay where the meeting is being held. When making your reservations, please indicate that you will be attending the EPA meeting; the telephone number is (919) 941-5050. The Sheraton does provide a courtesy airport limousine.

Sincerely,

/s/

Jack R. Farmer
Chairperson
National Air Pollution Control
Techniques Advisory Committee

3 Enclosures

OAQPS: ESD: OD: MJClark: mjclark, rm 741, NCM, x5571 (MD-13): 3/31/88
bcc: Deb Michelitsch, ESD/ISB (3 copies: ISB file and 2 for docket)
Dianne Byrne, ESD/SDB

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Results of the Asphalt Processing and Asphalt Roofing Manufacturing NSPS Review

This document presents the recommendations developed as a result of the information gathered during the Asphalt Processing and Asphalt Roofing Manufacturing NSPS Review.

Recommendations

- Note, in the Federal Register review notice, that there will be no changes to the emission limits of the NSPS.

- Revise the wording of the NSPS to clarify that coaters, when used to produce fiberglass-based products, are subject to the NSPS, and are defined as a "saturator" under the existing definition of "saturator." The mass emission limit will be 0.04 kg/Mg corresponding to the existing emission limit for conventional shingle production, and the opacity and fugitive visible emission limits will be the same as for a conventional "saturator." If process modifications, rather than add-on controls, are used to control emissions from coaters producing fiberglass-based products, these modifications are to be reported to the EPA, and a continuous monitoring system for process parameters installed as agreed upon with EPA, to ensure that these process modifications are used on a continuous basis. These modifications and monitored parameters are likely to be considered confidential by the users of these techniques.

- Revise the wording of the NSPS to clarify that modified bitumen asphalt roofing production is subject to the NSPS. The mix tanks and impregnation vats combined will be defined as the "saturator," and the mass emission limit will be 0.04 kg/Mg (for modified bitumen membrane that is either smooth or mineral surfaced). The same opacity and fugitive visible emissions limits as applied to conventional "saturators" will apply to modified bitumen "saturators." Any asphalt storage facilities, mineral handling and storage facilities, or blowing stills at a modified bitumen facility will be subject to the same limits as those located at a conventional roofing plant.

- Prepare a memo to the Stationary Source Compliance Division (SSCD) recommending that information be provided to the regulatory agencies so as to increase their awareness of the requirements of the regulation.

Background

The NSPS were promulgated on August 6, 1982, limiting emissions of particulate matter from new, modified and reconstructed affected facilities at asphalt roofing plants, asphalt processing plants, and petroleum refineries. The standards apply to any "saturator," mineral handling and storage facility, and asphalt storage tank or blowing still that processes and/or stores asphalt used for roofing only or for roofing and other purposes, that have been built, modified, or reconstructed after November 18, 1980. Any asphalt storage tank or blowing still that processes and/or stores only non-roofing asphalt and has been built, modified, or reconstructed after May 26, 1981, is also subject to these standards. These standards are summarized in Table 1.

Scope of Review

The following tasks were undertaken in this study:

- Evaluation of production and particulate control technologies currently operating at asphalt processing and asphalt roofing manufacturing facilities constructed or modified since 1980.
- Evaluation of modified bitumen asphalt roofing production facilities.
- Examination of the cost effectiveness of the NSPS.
- Review of the effectiveness and suitability of the monitoring and testing requirements of the NSPS.
- Review of the available compliance test reports.
- Examination of difficulties encountered by industry in complying with the NSPS.

Approach

The Stationary Source Compliance Division and various Regional Offices and State agencies were contacted to determine the number of facilities that have become subject to this NSPS since its promulgation. Available NSPS compliance test data, cost data, and opinions of industry personnel regarding the NSPS were solicited through visits to six plants and Section 114 letters that covered 20 plants. Cost and cost effectiveness calculations were performed for the model affected facilities assuming two yearly operating periods, and two types of precooling systems (where appropriate), as is representative of industry operating practice.

TABLE 1

SUMMARY OF THE NSPS

Affected Facility	Definition	Mass Emissions kg/Mg	Opacity	VE
"Saturator"	Includes saturator, wet looper, and coater	0.04 - shingles and mineral surfaced rolls 0.4 - saturated felt and smooth surfaced rolls	20%	No fugitive visible emissio for more than 20% of the consecutive val observations totalling 60 minutes
Mineral Handling and Storage	Unloading point, storage area, and transfer points between the two	--	1%	--
Asphalt Storage Tank	At roofing plants, refineries, & processing plants. Does not include cutback or emulsified asphalts	--	0% Except for one 15-min period in every 24 hours to clear transfer lines	--
Blowing Still	Used to blow air through flux to alter softening point and penetration	0.60 - 0.71 depending upon fuel & catalyst use	0% unless a special limit has been granted when using fuel oil	--

Findings

1. Technology Changes

No new technology for the control of particulate emissions from asphalt processing and asphalt roofing manufacturing has emerged since development of the NSPS. However, there have been changes in production technology. Fiberglass based products have become the predominant portion of the industry, with recent trends indicating that the organic sector is becoming an increasingly smaller segment of the total industry. The fiberglass product production process does not use a saturation or wet looping step. It only has a coating step, which eliminates the major portion of "saturator" emissions. During the original NSPS development process, no data was collected on the manufacture of fiberglass roofing products; it was a very small segment of the industry, and it was assumed that these facilities would be able to easily meet the emission limits due to the absence of a saturator and wet looper.

Modified bitumen asphalt roofing has become a new sector of the asphalt roofing industry since the original NSPS development. This product consists of a polyester or fiberglass web impregnated with an asphalt/polymer mixture, and occasionally surfaced with granules. The uncontrolled particulate emissions per unit of product from the production of modified bitumen are considerably less than those from a conventional roofing manufacturing process; a conventional plant operating 8,000 hrs/yr would produce 145 tons of particulate emissions (when uncontrolled), as compared to 20 tons from an uncontrolled modified bitumen plant also operating 8,000 hrs/yr.

2. Industry Size and Production Trends

The Asphalt Roofing Manufacturers Association (ARMA) furnished a list of 88 member company plants as of May 1, 1987, owned by 31 companies. In comparison, there were 118 plants in 1977 (109 of which were ARMA members), owned by 27 companies. Twenty of the plants currently operating report the capability to produce modified bitumen membrane; 15 produce only that product. These 15 plants are assumed to be totally new facilities.

During the original NSPS development, it was estimated that the production of all asphalt roofing products would show a net increase of 4 to 8 percent over a 5-year period. Representatives of the ARMA have stated that the current industry capacity is less than was expected in 1980. Between 1977 and 1986, the production of strip shingles increased by 43 percent; production of individual shingles decreased by 40 percent, while production of roll roofing stayed approximately the same, and total production of shingles and rolls increased by 27 percent.

In 1977, only 5 percent of shingles were fiberglass, whereas in 1986, over 75 percent of all roofing was fiberglass. This change over to fiberglass based products has resulted in an increase in the production capabilities of an individual roofing plant (thus the increase in total industry capacity with fewer plants). This is largely due to the fact that the use of fiberglass mat, which is more uniform than organic felt, results in less frequent line breaks. Also, when line breaks do occur, they are much easier to correct since there is no saturator involved. No new equipment is needed to switch an existing organic shingle line to production of fiberglass shingles, and less asphalt is used.

Since the original NSPS was developed, saturated felt has been divided into two categories; saturated felt and ply felts. Saturated felt is still organic, with production quantities being reported as tons per year. However, ply felts are now either organic or fiberglass, and production is reported as squares per year. Consequently, an accurate assessment of the growth in the production of "felts" since the original NSPS is not possible.

Modified bitumen asphalt roofing is a growing portion of the industry, which comprises 9 percent of the commercial roofing sector. Actual production statistics are not available at this time, and future growth patterns cannot be accurately predicted.

3. Compliance Status and Emissions Data

Thirty-one asphalt processing and asphalt roofing manufacturing plants have been identified as having some or all facilities subject to the NSPS. A list of these plants and their respective affected facilities is shown in the attached Table A. Emissions data were received for 17 plants. These were all the data that could be obtained within the limitations of the nine Section 114 letters. Only seven of the emission test reports were complete. The compliance data collected during this review are also shown in the attached Table A. All of the particulate emissions data that were received during this review were well within the allowable NSPS limits, as shown in Figure 1 (page 8).

Compliance with Saturator Emission Limits

For saturators producing saturated felt (for which the process does not include a coater), the data received from three plants varied from 0.0124 kg/Mg to 0.175 kg/Mg as compared to an allowable emission limit of 0.4 kg/Mg. All of these units were controlled by mist eliminators with induced air precooling or cooling of the exhaust gas via extra length of ductwork.

Three plants reported emissions data from coaters that were producing fiberglass mineral surfaced products (this process utilizes a coater only and does not include the saturator or wet looper). There were no control devices associated with these three coaters, but proprietary process modifications were reportedly used to reduce emissions. Particulate emissions from two of these facilities were 0.005 kg/Mg and 0.007 kg/Mg. At the third plant, the combined emissions from the coater and an asphalt surge tank were 0.004 kg/Mg. All three of these facilities had an allowable emission limit of 0.04 kg/Mg. However, as previously noted, this limit of 0.04 kg/Mg was originally developed for the combination of a saturator, wet looper, and coater, when used to produce organic products.

Several States and Regions have enforced this limit for the production of fiberglass products, which uses only the coater.

A fourth plant reported emissions of 0.0015 kg/Mg for a coater controlled by an electrostatic precipitator (ESP), but the methodology for this test appears incorrect. The filter temperature reported is that required by EPA Reference Method 5 (248 ± 25°F), not that for Method 5A (108 ± 18°F) as specified by the NSPS. This higher temperature will result in the escape of some gas phase hydrocarbons that would be condensed and captured at the lower temperature required by Method 5A. Consequently, the particulate emissions concentration reported is most likely a low value.

For two additional plants, the emissions data were reported for the case where emissions from two different roofing lines (one producing organic roofing and the other fiberglass) were combined and ducted to one control device. In both cases the emissions limit enforced was 0.04 kg/Mg during the manufacture of both organic and inorganic mineral surfaced products simultaneously. The particulate emissions concentration measured for the plant using a mist eliminator as the control device was 0.0099 kg/Mg, and that from the plant using a scrubber followed by a high velocity air filter (HVAF) was 0.018 kg/Mg.

Modified Bitumen Emissions Data

Since modified bitumen asphalt roofing was not being produced when the NSPS was developed, there have been uncertainties in interpretation of the applicability of the standard to modified bitumen production. As a result, there have been inconsistencies in enforcement of the NSPS for these plants among the regulatory agencies. Data were received for emissions tests at three modified bitumen production plants, all of which had particulate emissions of less than 20 percent of the standard. In each case, the product was interpreted as being similar to smooth surfaced roll roofing, and the affected facility was classified as a saturator with an allowable emission limit of 0.4 kg/Mg. At one plant, the affected facility was defined as the impregnation vats (which were uncontrolled), and average uncontrolled particulate emissions were 0.03 kg/Mg. At the other two modified bitumen production plants, the affected facility was defined as the mixing tanks and the impregnation vats combined. One of these two plants used an oversized ESP, which was retrofit, to control emissions. Particulate emissions from this plant were 0.061 kg/Mg. The other plant used a series of household furnace filters as the control device and controlled emissions were measured at 0.06 kg/Mg.

Compliance with Blowing Still Emission Limit

Emissions data were received from testing performed at eight blowing stills controlled by afterburners. Emissions from three of these facilities ranged from 0.015 kg/Mg to 0.043 kg/Mg as compared to an allowable limit of 0.60 kg/Mg. An emissions concentration of 0.073 kg/Mg was reported for one blowing still with an allowable limit of 0.64 kg/Mg. Because the fuel used in the afterburner was not reported, the allowable emissions limit for three of the blowing stills is not known, but the controlled emissions from each of these were less than 4 percent of the most restrictive NSPS limit. The information for one blowing still was not sufficient to determine emissions per mass of product (which is the required format of the standard). Also, the test procedure for this facility appears to have been performed incorrectly.

As discussed above, all the reported emissions data for testing at blowing stills was well below the NSPS limitations. The afterburner operating characteristics for these units are summarized in the attached Table B. During the original NSPS development process, the highest emissions from testing of a blow still were 0.55 kg/Mg, for a blow still controlled by a natural gas fired afterburner operating at 1500°F. This resulted in the NSPS limit of 0.60 kg/Mg. The other allowable limits for the NSPS were developed to account for fuel oil and/or catalyst use by simply adding the particulate contribution from the oil or catalyst to the emissions data obtained from gas fired afterburners.

Compliance with Opacity and Visible Emission Limits

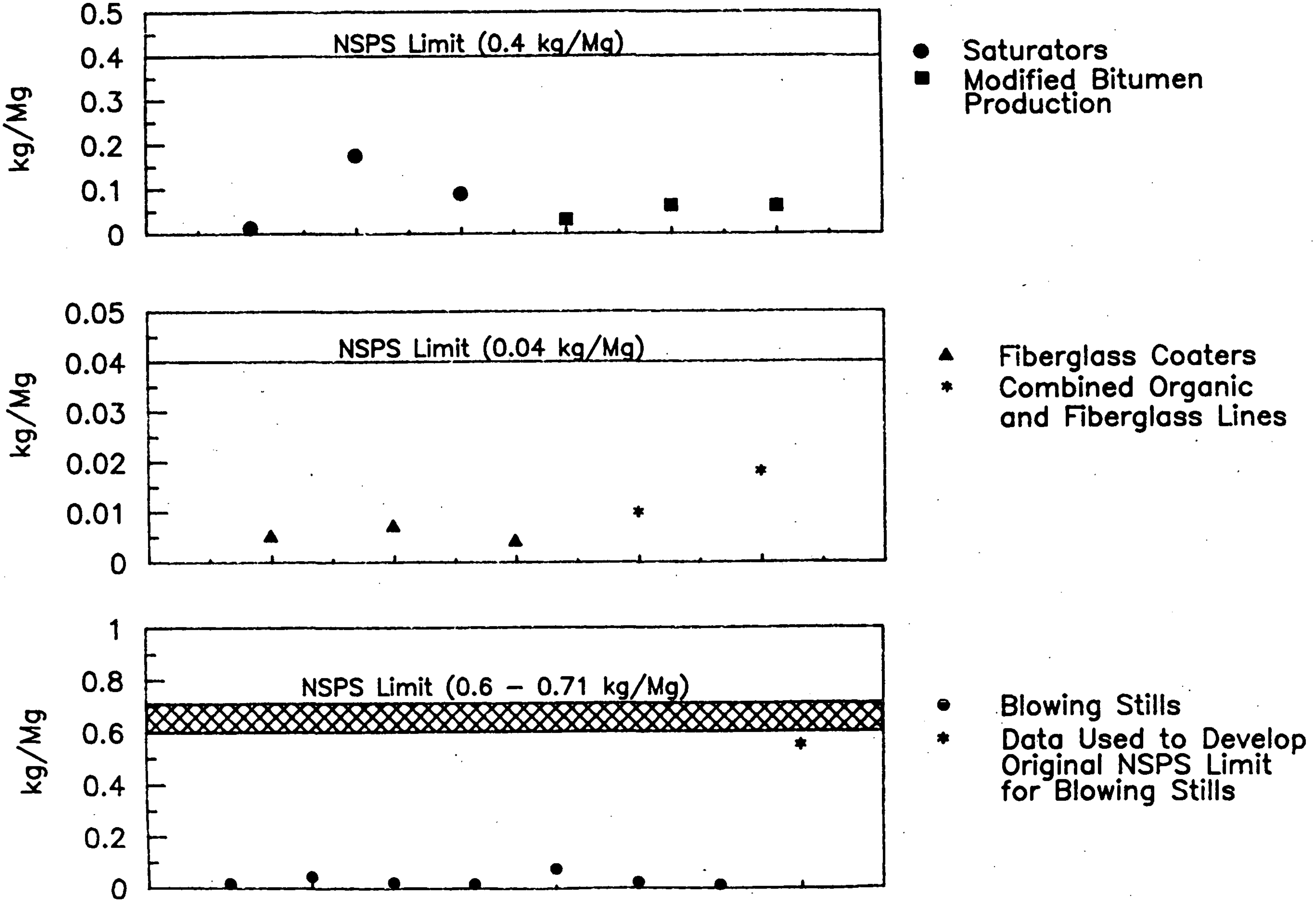
Opacity information was included in 13 of the 17 compliance data reports. Of these thirteen, opacities ranging from 0 to 5 percent were reported for four saturators; opacities from two coaters were reported to be between 1.7 and 15 percent; and opacities from two modified bitumen plants were reported to be between 0 and 5 percent (all of these facilities have an NSPS opacity limit of 20 percent). The opacities at six blowing stills were all reported as 0 percent, as required.

Visible emissions data from capture systems was reported for four facilities; all of these were in compliance (no visible emissions for more than a total of 12 out of 60 minutes). Compliance data for mineral handling and storage or asphalt storage (only opacity limits apply to these facilities) was received for one plant during the NSPS review; a mineral storage facility reported 0% opacity.

Monitoring Data

The required monitoring data for the control device operating temperature during the performance test were included with only nine of the 14 emission test reports. However, the routine continuous monitoring of these temperatures is being carried out by 12 of the facilities.

FIGURE 1
COMPLIANCE DATA



4. Cost Effectiveness of NSPS

The cost effectiveness values for controlling particulate emissions from the various affected facilities are summarized below. A more detailed presentation is shown in the attached Tables C, D, and E. The information is based upon the uncontrolled case and has been calculated for two representative scenarios for annual operating hours. The cost effectiveness for use of ESP's, HVAF's, and mist eliminators was determined assuming two different precooling systems; evaporative recirculating precooling, and finned tube precooling. Both automatic and manual cleaning were examined for ESP's.

The ranges of cost effectiveness values for the various affected facilities are as follows:

	$/TON
- Saturator, Wet Looper, and Coater	600 - 1,000
- Fiberglass Mat Coater	7,000 - 10,000
- Mineral Handling and Storage	
Filler	1,200
Parting Agent	1,500
- Asphalt Storage	1,700 - 4,000
- Blowing Stills	30
- Modified Bitumen Production	
Mix Tanks	3,000 - 4,000
Impregnation Vats	50,000 - 60,000

Blowing stills have a low cost effectiveness because the effluent is used as a portion of the fuel for the afterburner, and heat is recovered from the unit. Modified bitumen mix tanks controlled by afterburners have a higher cost effectiveness due to a lower heating value of the effluent. Also, the extremely high cost effectiveness for modified bitumen impregnation vats is a result of a very low uncontrolled pollutant loading.

Recommendations

We recommend that no changes be made to the NSPS mass particulate emission limits. There have been no changes in the types of control technology used in the industry. The data indicates that this technology is capable of reducing emissions to below the NSPS limits, and is cost effective. Therefore, lowering the standard would not require any new control technology and consequently not achieve any additional emissions reduction. The blowing still emissions data that is well below the current standard (less than 5 percent of the allowable NSPS limit) was obtained from installations with operating conditions similar to those encountered during the original NSPS development test program. The emission data used to develop the current mass standard for blowing stills was gathered at one non-catalytic still controlled by a natural gas fired afterburner operating at about 1500°F with an unknown residence time. The highest individual test reading of 0.55 kg/Mg resulted in the NSPS limit of 0.60 kg/Mg. At this time, we have no reason to discard this information. Tightening the standard would not result in application of control equipment any different than that presently being installed to meet the NSPS and, therefore, would not result in further emissions reductions. For reasons discussed above, we recommend no change to the blow still limits.

We recommend that coaters used to produce fiberglass-based products and mix tanks and impregnation vats used to produce modified bitumen asphalt roofing products be subject to the existing standards. This recommendation is based on the conclusion that, if an industry makes process refinements or develops new processes for cost or other reasons for processes for which an NSPS exists, then those processes should continue to be required to meet an emission level at least as stringent as the existing NSPS requirements. Improvements in production processes should not be at the expense of the environment, and the control of process emissions should be an important consideration while developing process changes. The Agency has already implemented this policy where such changes have occurred in the area of auto painting for which there is an existing NSPS.

The production of fiberglass roofing products has apparently reduced the production costs for the industry by simplifying the process, increasing capacity of individual existing plants, and reducing asphalt usage. Also, the uncontrolled emissions from fiberglass roofing production are less than those from conventional roofing production. The production of roofing products through the modified bitumen process is also new to the industry. Emissions from the modified bitumen production line are significantly lower than uncontrolled emissions from conventional roofing production. Therefore, the conclusion that coaters used to produce fiberglass-based products, and mix tanks and impregnation vats used to produce modified bitumen products will be subject to the NSPS is consistent with Agency policy.

During the production of conventional organic-based roofing products, the "saturator" (which is defined as the saturator, wet looper, and coater combination) performs the function of filling the voids between the organic felt fibers with asphalt, and then coating the impregnated sheet with a layer of asphalt. In fiberglass roofing production, the coater alone performs the function of filling the voids between the fiberglass web fibers with asphalt and coating the sheet with a layer of asphalt, thus resulting in lower uncontrolled emissions. Therefore, for fiberglass roofing production lines, the coater is defined as the "saturator." Using the emissions data and process and product parameters gathered during this review, we have concluded that the mass emission limit applicable during the production of fiberglass products is 0.04 kg/Mg, the same limit that is applicable to a conventional "saturator" producing shingles. This limit should be achievable using the same add-on controls as for conventional roofing production.

For modified bitumen asphalt roofing production, the mix tanks and impregnation vats are the facilities used to produce the roofing product. In this process heated asphalt and other products are mixed in the mix tanks and this mixture is then used to impregnate and coat a sheet of polyester webbing as it passes through the impregnation vat. This roofing process also has lower uncontrolled emissions than a conventional roofing "saturator." The mix tanks and impregnation vats combined are defined as the "saturator" for this process. Using the emissions data and process and product parameters gathered during this review, we have concluded that the mass emission limit applicable during the production of smooth or granule surfaced modified bitumen is 0.04 kg/Mg, the same limit that is applicable to a conventional "saturator" producing shingles. This limit should be achievable using the same add-on controls as for conventional roofing production.

We recommend that steps be taken to increase the awareness of the regulatory agencies of the monitoring and performance test requirements of the NSPS. Information and data were often difficult to obtain because representatives of the regulatory agencies were often lacking in knowledge of the standard. Control device temperature monitoring data taken during the performance test, as well as the results of EPA Methods 9 (opacity) and 22 (fugitive visible emissions from hoods) are often not being included with the test report, as required. If a plant had an affected facility with an opacity standard only (mineral storage and handling, asphalt storage), there were usually no compliance reports available. Also, there were two instances of use of an improper test method. The suggested course of action is to prepare a memo to SSCD recommending that regulatory agencies be informed that opacity, fugitive visible emissions and operating temperature monitoring data from compliance testing be included as in integral part of the test report.

5 Attachments

TABLE A
COMPLIANCE STATUS OF ASPHALT PROCESSING AND ASPHALT ROOFING MANUFACTURING PLANTS

Plant	Affected Facility	Compliance Data				Comments
		PM Conc. (kg/Mg)	Opacity (%)	Fugitive Emissions	Temperature Monitoring	
Georgia-Pacific Hampton, GA	Saturator	Avg. 0.175	1.0	Comply	Inc. w/test	Product is saturated felt, control device is a mist eliminator.
	Filler Storage	N/R	NDR	N/R	N/R	
Georgia-Pacific Daingerfield, TX	Saturator	Avg. 0.0124	3.5	NDR	Inc. w/test	Product is saturated felt, control device is a mist eliminator.
	Filler Storage	N/R	NDR	N/R	N/R	
Woodland Industries Griffen, GA	Saturators (2)	Avg. 0.089	5.0	Comply	Inc. w/test	Product is saturated felt, one mist eliminator controls both saturators.
Tamko Asphalt Products, Inc. Frederick, MD	Saturator	Avg. 0.018	0	NDR	NDR	A scrubber and HVAF controlled two lines during the test; one is a saturator/wet looper/coater, and one is a coater only. The saturator is the subject facility. The products are organic roll roofing and inorganic shingles.
Tamko Asphalt Products, Inc. Joplin, MO	Coater	Avg. 0.0099	1.7	Comply	NDR	A mist eliminator unit was controlling two lines during test. One is a saturator/wet looper/coater and one is a coater only. The coater only line is subject. Both organic and inorganic shingles were being produced.
	Asphalt Storage	N/R	NDR	N/R	N/R	
	Filler Handling & Storage	N/R	NDR	N/R	N/R	
	Parting Agent Storage & Handling	N/R	NDR	N/R	N/R	
	Blowstills (3)	NDR	NDR	N/R	NDR	Incinerators fired with natural gas.
Owens Corning Fiberglas Corp. Summit, IL	Coater	Avg. 0.004	NDR	NDR	N/R	Uncontrolled emissions (with process modifications) from both coater and asphalt surge tank combined were tested. Fiberglass products. Allowable emissions of 0.04 kg/Mg.
	Asphalt Storage (Surge)	N/R	See Comments	N/R	N/R	
Owens Corning Fiberglas Corp. Irving, TX	Coater	Avg. 0.007	NDR	NDR	N/R	Uncontrolled unit (with process modifications). Fiberglass products. Allowable emissions of 0.04 kg/Mg.
	Blowstills (2)	Avg. 0.016	NDR	N/R	NDR	Average of three test runs on incinerator (waste heat boiler), two runs on only one still, one run on both. Fuel unknown.
	Parting Agent Storage	N/R	NDR	N/R	N/R	
	Filler Storage & Handling	N/R	NDR	N/R	N/R	
Owens Corning Fiberglas Corp. Medina, OH	Coater	Avg. 0.005	5 - 15	NDR	N/R	Uncontrolled unit (with process modifications). Fiberglass products. Allowable emissions of 0.04 kg/Mg.
	Blowstill	Avg. 0.043	0	N/R	Inc. w/test	Fuel unknown. Allowable emissions are 0.60 kg/Mg. Incinerator (asphalt preheater) is the control device.
	Parting Agent Storage & Handling	N/R	0	N/R	N/R	
	Filler Storage & Handling	N/R	0	N/R	N/R	
Owens Corning Fiberglas Corp. Ft. Lauderdale, FL	Blowstill	Avg. 0.073	0	N/R	Inc. w/test	Incinerator (asphalt preheater) fired w/fuel oil. Allowable emissions are 0.64 kg/Mg.
Owens Corning Fiberglas Corp. Jacksonville, FL	Blowstill #1	Avg. 0.021	0	N/R	Inc. w/test	The same incinerator (waste heat boiler) controls both stills, apparently at different times. Fuel unknown.
	Blowstill #2	Avg. 0.011	0	N/R	Inc. w/test	
	Parting Agent Handling	N/R	NDR	N/R	N/R	

TABLE A
COMPLIANCE STATUS OF ASPHALT PROCESSING AND ASPHALT ROOFING MANUFACTURING PLANTS

		Compliance Data				
Plant	Affected Facility	PM Conc. (kg/Mg)	Opacity (%)	Fugitive Emissions	Temperature Monitoring	Comments
Owens Corning Fiberglas Corp. Jessup, MD	Blowstill	Avg. 0.02	0	N/R	Inc. w/test	Incinerator (waste heat boiler). Fuel unknown. Allowable emissions are 0.60 kg/Mg.
Tamko Asphalt Products, Inc. Tuscaloosa, AL	Blowstill	Avg. 0.015	0	N/R	Inc. w/test	Incinerator. Allowable emissions are 0.60 kg/Mg. Fired with natural gas.
U.S. Intec, Inc Port Arthur, TX	Modified Bitumen Vats	Avg. 0.03	5	Comply	N/R	Uncontrolled. Product considered smooth roll roofing.
GAF Corporation Mount Vernon, IN	Modified Bitumen Vats & Mixing Tanks	Avg. 0.061	0	NDR	Inc. w/test	One ESP controls mix tanks and vat. Product considered smooth roll roofing. No actual opacity data, just statement of no visible discharge from stack. ESP oversized.
	Blowstill	NDR	NDR	N/R	NDR	
	Filler Handling	N/R	NDR	N/R	N/R	
Nord Bitumi U.S., Inc. Plattsburgh, NY	Modified Bitumen Vats & Mixing Tanks	Avg. 0.06	NDR	NDR	N/R	Mix tanks and vat controlled by a series of household furnace filters. Product considered smooth roll roofing.
	Filler Storage	N/R	NDR	N/R	N/R	
GAF Corporation Fontana, CA	Coater	Avg. 0.0015	NDR	NDR	NDR	This data is for an ESP controlling the emissions. The test method, however, appears to be EPA Method 5, not 5A as required. The temperature is Method 5, but it is unknown whether the solvent is that for Method 5 or 5A. Data is then probably a lenient estimate of emissions.
	Filler Handling	N/R	NDR	N/R	N/R	
GAF Corporation Baltimore, MD	Blowstill	Avg. 0.273 (kg/hr)	0	N/R	NDR	The information to determine emissions per mass of product not supplied in test report for this incinerator. Test description states use of EPA Method 5, but actual reports appear to be at Method 5A temperatures. Description of test indicates use of acetone as solvent (as in Method 5, Method 5A uses trichloroethane); actual is unknown. Afterburner is fired with natural gas. Allowable emissions of 0.60 kg/Mg.
	Filler Storage	N/R	NDR	N/R	N/R	
Bird Incorporated Norwood, MA	Saturator	NDR	NDR	NDR	NDR	Work being done to bring saturator into compliance.
	Coater	NDR	NDR	NDR	NDR	
Owens Corning Fiberglas Corp. Houston, TX	Coater	NDR	NDR	NDR	NDR	Uncontrolled
Owens Corning Fiberglas Corp. Kearny, NJ	Coater	NDR	NDR	NDR	NDR	
	Filler Handling & Storage	N/R	NDR	N/R	N/R	
	Parting Agent Handling & Storage	N/R	NDR	N/R	N/R	
Tamko Asphalt Products, Inc. Phillipsburg, KS	Saturators (2)	NDR	NDR	NDR	NDR	
	Blowstill	NDR	NDR	N/R	N/R	Incinerator fired with natural gas. Allowable emissions are 0.60 kg/Mg.
	Asphalt Storage	N/R	NDR	N/R	N/R	
	Filler Handling & Storage	N/R	NDR	N/R	N/R	
	Parting Agent Handling & Storage	N/R	NDR	N/R	N/R	

TABLE A
COMPLIANCE STATUS OF ASPHALT PROCESSING AND ASPHALT ROOFING MANUFACTURING PLANTS

Plant	Affected Facility	Compliance Data				Comments
		PM Conc. (kg/Mg)	Opacity (%)	Fugitive Emissions	Temperature Monitoring	
Ennis Asphalt Ennis, TX	Blowstill	NDR	NDR	N/R	NDR	
Celotex Corporation Goldsboro, NC	Filler Handling & Storage	N/R	NDR	N/R	N/R	
Certainteed Corp. Oxford, NC	Filler Handling	N/R	NDR	N/R	N/R	
Elk Corporation of America Tuscaloosa, AL	Mineral Handling	N/R	NDR	N/R	N/R	
	Asphalt Storage	N/R	NDR	N/R	N/R	
Asphalt for Roofing Houston, TX	unknown					
Manville Corp. Ft. Worth, TX	unknown					
SRS Industries Waxahachie, TX	unknown					
Tarco Inc. Belton, TX	unknown					
Tarco Inc. Waco, TX	unknown					
Texas Refining Corp. Ft. Worth, TX	unknown					

PM - particulate matter
NDR - no data received during this NSPS review
N/R - not required for compliance
Comply - meets fugitive visible emission limit as measured by EPA Method 22

TABLE B
BLOWING STILL AFTERBURNER CHARACTERISTICS

PLANT	TEMP[a,b] (°F)	RES TIME[b] (SEC)	EMISSIONS ACTUAL (kg/Mg)	 ALLOWABLE (kg/Mg)	FUEL TYPE	CATALYST USE	OPERATING TEMPERATURE MONITORING
OWENS-CORNING							
FIBERGLAS CORP.							
-Irving, TX	1600	0.55	0.016	NDR	NDR	No	Continuous monitor, and checked once per shift
-Ft. Lauderdale, FL	1200-1600	0.22	0.073	0.64	Oil	No	Continuous monitor, and checked once per shift
-Medina, OH	1400	0.2	0.043	0.60	NDR	CBI	Continuous monitor, and checked once per shift
-Jacksonville, FL	1400	2.3	0.021	NDR	NDR	No	Continuous monitor, and checked once per shift
(One A/B, two stills)	1400	2.3	0.011	NDR	NDR	No	Continuous monitor, and checked once per shift
-Jessup, MD	1400	1.5	0.020	0.60	NDR	No	Continuous monitor, and checked once per shift
TAMKO ASPHALT							
PRODUCTS, INC.							
-Tuscaloosa, AL	1300	2.0	0.015	0.60	Gas	CBI	Continuous monitor and checked every 15 minutes
-Joplin, MO	1400-1600	0.7	NDR	NDR	Gas	CBI	Plant personnel monitor the temperature
(Four stills, two A/B)	1400-1600	0.7	NDR	NDR	Gas	CBI	Plant personnel monitor the temperature
-Phillipsburg, KS	1200-1600	NDR	NDR	0.60	Gas	No	Plant personnel monitor the temperature
GAF CORPORATION							
-Mt. Vernon, IN	NDR	NDR	NDR	NDR	NDR	No	NDR
-Baltimore, MD	1000	4.7	0.273 (kg/hr)	0.60	Gas	No	Continuous monitor and checked every hour

NDR - no data received during this NSPS review
CBI - confidential business information

a. Temperature not included in test report as required; was obtained by Section 114 Information Request.

b. Temperature and residence times assumed during original NSPS development were 1300-1500 °F and 0.3-0.5 seconds. The temperature used for the model plant in this review was 1400 °F.

TABLE C

COST EFFECTIVENESS: ELECTROSTATIC PRECIPITATOR, HIGH VELOCITY AIR FILTER AND MIST ELIMINATOR CONTROL SYSTEMS EVAPORATIVE RECIRCULATING PRECOOLER

Second Quarter 1987 Dollars

		Pollution Control Cost Effectiveness(1)							
		Electrostatic Precipitator							
		Automatic Cleaning		Manual Cleaning		High Velocity Air Filter		Mist Eliminator	
Facility	Annual Operating Hours	$/Mg	$/Ton	$/Mg	$/Ton	$/Mg	$/Ton	$/Mg	$/Ton
Saturator Wet Looper & Coater	4000	911	826	896	813	1,140	1,030	1,090	989
	8000	659	598	652	592	878	797	792	718
Fiberglass Mat Coater	4000	9,590	8,713	9,400	8,540	11,000	10,000	10,100	9,180
	8000	7,010	6,370	6,910	6,280	8,400	7,630	7,500	6,800
Modified Bitumen Mixing	5000	3,090	2,810	3,060	2,780	3,780	3,430	3,720	3,380
	8000	2,730	2,480	2,710	2,460	3,274	2,970	3,180	2,884
Modified Bitumen Impregnation	5000	59,000	53,500	57,700	52,400	71,100	64,500	65,700	59,600
	8000	48,900	44,300	48,100	43,600	60,300	54,600	53,100	47,900

(1)All values are calculated from a baseline of no control.

TABLE D

COST EFFECTIVENESS: ELECTROSTATIC PRECIPITATOR, HIGH VELOCITY AIR FILTER AND MIST ELIMINATOR CONTROL SYSTEMS FINNED TUBE PRECOOLER

Second Quarter 1987 Dollars

		Pollution Control Cost Effectiveness[1]							
		Electrostatic Precipitator							
		Automatic Cleaning		Manual Cleaning		High Velocity Air Filter		Mist Eliminator	
Facility	Annual Operating Hours	$/Mg	$/Ton	$/Mg	$/Ton	$/Mg	$/Ton	$/Mg	$/Ton
Saturator Wet Looper & Coater	4000	890	810	880	800	1,120	1,010	1,070	970
	8000	670	610	660	600	890	800	800	730
Fiberglass Mat Coater	4000	9,120	8,290	8,950	8,130	10,600	9,600	10,400	9,420
	8000	6,910	6,277	6,820	6,200	9,130	8,290	7,780	7,050
Modified Bitumen Mixing	5000	3,950	2,680	2,910	2,640	3,640	3,300	3,580	3,240
	8000	2,650	2,410	2,630	2,380	3,190	2,890	3,110	2,820
Modified Bitumen Impregnation	5000	58,000	52,600	57,000	51,700	70,400	63,800	65,000	59,000
	8000	49,000	44,300	48,300	43,800	60,600	54,900	53,300	48,100

[1] All values are calculated from a baseline of no control.

TABLE E

COST EFFECTIVENESS: FABRIC FILTER, AFTERBURNER WITH HEAT RECOVERY AND ASPHALT STORAGE MIST ELIMINATOR CONTROL SYSTEMS

Second Quarter 1987 Dollars

		Pollution Control Cost Effectiveness[1]					
		Mist Eliminator		Fabric Filter		After Burner With Heat Recovery	
Facility	Annual Operating Hours	$/Mg	$/Ton	$/Mg	$/Ton	$/Mg	$/Ton
Filler Surge & Storage	4000			1,390	1,260		
	8000			1,300	1,180		
Parting Agent Surge & Storage	4000			1,730	1,570		
	8000			1,610	1,460		
Asphalt Storage	800	4,760	4,310				
	4800	1,823	1,656				
Blowing Stills	2000					32	29
Modified Bitumen Mixing						5,100	4,630
						4,400	3,990

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[1] All values are calculated from a baseline of no control.

United States
Environmental Protection
Agency

Office of Air Quality
Planning and Standards
Research Triangle Park NC 27711

January 1988

Air

EPA

Review of New Source Performance Standards for Asphalt Processing and Asphalt Roofing Manufacture

Preliminary Draft

NSPS

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Preliminary Draft

Emission Standards Division

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park NC 27711

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1.0 SUMMARY

The new source performance standards (NSPS) for asphalt processing, and asphalt roofing manufacturing plants were promulgated by the U.S. Environmental Protection Agency (EPA) on August 6, 1982, under Section 111 of the Clean Air Act. The standards limit emissions of particulate matter from any saturator, mineral handling and storage facility, and asphalt storage tank or blowing still that processes and/or stores asphalt used for roofing only or for roofing and other purposes, that have been built, modified, or reconstructed after November 18, 1980. Any asphalt storage tank or blowing still that processes and/or stores only non-roofing asphalts and has been built, modified, or reconstructed after May 26, 1981, is also subject to these standards.

The objective of this report is to document the review of the NSPS for asphalt processing, and asphalt roofing manufacturing plants, and to assess the need for revision on the basis of developments that have occurred since the standard was promulgated. This review is required under Section 111(b) of the Clean Air Act, as amended. The following paragraphs summarize the findings of this review.

1.1 INDUSTRY TRENDS

Although the capacity of the asphalt roofing industry has increased, the total number of plants has declined. This is a result of the increased manufacture of fiberglass based materials, which now comprise over 75 percent of all roofing products.

Since the development of the original NSPS, a new type of material has emerged in the asphalt roofing industry. Modified bitumen is comprised of a polyester of fiberglass base mat which has been impregnated with an asphalt/polymer mixture. The production of modified bitumen comprises approximately 9 percent of the commercial roofing sector.

1.2 CONTROL TECHNOLOGY

The air pollution control devices used in the asphalt roofing industry have remained essentially the same. Emissions from the saturator, wet looper, and/or coater are controlled by high velocity air filters (HVAF), electrostatic precipitators (ESP), and mist eliminators (ME). Asphalt blowing stills, asphalt storage tanks, and mineral handling and storage facilities are controlled by afterburners (A/B), mist eliminators, and baghouses respectively. Modified bitumen impregnation vats can be controlled by HVAF's, ESP's, and ME's, with the mixing tanks utilizing the same type of controls as well as A/B's. All of the emissions data collected during this review was well within the applicable NSPS allowable limits.

1.3 ECONOMIC CONSIDERATIONS

Another primary issue involving review of the NSPS is the cost of controls. The cost effectiveness of controlling particulate emissions from the various affected facilities at an asphalt roofing plant were estimated for each possible control device. For a saturator, wet looper, and coater combination, the cost of control per unit of particulate collected ranged from $600 to $1,000 per ton; for a coater only (producing fiberglass products), between $7,000 and $10,000. Mineral handling and storage, and asphalt storage had control costs of between $1,200 and $1,500 per ton, and $1,700 to $4,000 per ton, respectively. Asphalt blowing stills controlled by afterburners showed a cost effectiveness of approximately $30 per ton. Modified bitumen mixing control costs were estimated to be between $3,000 and $4,000 per ton, whereas costs for control of modified bitumen impregnation vats ranged from $50,000 to $60,000 per ton.

2.0 INTRODUCTION

2.1 SCOPE OF THE REVIEW

The Clean Air Act Amendments of 1977 require that the Administrator of EPA review and, if appropriate, revise established standards of performance for new stationary sources (NSPS) at least every 4 years.[1] The purpose of this report is to document this review and to assess the need for revision of the existing standards for asphalt processing and asphalt roofing manufacturing, based on developments that have occurred or are expected to occur within the industry. The information presented in this report was obtained from reference literature, discussions with industry representatives, trade organizations, process and control equipment vendors, EPA Regional Offices, and State and local agencies. Additional information was obtained from plant surveys, and responses to information requests under Section 114 of the Clean Air Act.[2]

The review conducted to assess the current NSPS for asphalt processing and asphalt roofing manufacturing included several areas, such as:

- new manufacturing processes (fiberglass based materials, modified bitumen)
- technologies being used for compliance
- enforcement and compliance experiences.

2.2 CURRENT STANDARDS

This section presents the current regulations for particulate and visible emissions from asphalt processing and asphalt roofing manufacturing. Federal regulations for new sources, and State regulations (for existing and new sources) are both addressed.

A summary of the NSPS is first presented, followed by detailed discussions of the requirements, definitions, and specifications of the NSPS. This is followed by a brief summary of applicable State regulations for this source category.

2.2.1. New Source Performance Standards.

2.2.1.1. Background. New source performance standards regulate emissions of air pollutants from new, modified, and reconstructed facilities in various industrial categories. The authority for the NSPS regulations is granted to the U.S. Environmental Protection Agency (EPA) under section 111 of the Clean Air Act.[3]

The regulation for asphalt processing and asphalt roofing manufacture is listed in Subpart UU of 40 CFR 60, (Code of Federal Regulations; Title 40- Protection of Environment; Part 60 - Standards of Performance for New Stationary Sources; Subpart UU - Standards of Performance for Asphalt Processing and Asphalt Roofing Manufacture). Subpart UU addresses specific requirements for this source category, but Subpart UU also incorporates the general requirements for any NSPS. These general requirements are listed in Subpart A (General Provisions) of 40 CFR 60.

2.2.1.2 Summary of the NSPS for Asphalt Processing and Asphalt Roofing Manufacture. New source performance standards were promulgated by the EPA on August 6, 1982, limiting emissions of particulate matter from new, modified and reconstructed affected facilities at asphalt roofing plants, asphalt processing plants, and petroleum refineries. The standards apply to any saturator, mineral handling and storage facility, and asphalt storage tank or blowing still that processes and/or stores asphalt used for roofing only or for roofing and other purposes, that have been built, modified, or reconstructed after November 18, 1980. Any asphalt storage tank or blowing still that processes and/or stores only nonroofing asphalts and has been built, modified, or reconstructed after May 26, 1981, is also subject to these standards.

The NSPS emission limits are as follows:

For saturators -

- ° Emissions shall not exceed 0.04 kilograms of particulate matter per megagram of asphalt shingle or mineral-surfaced roll roofing produced, or 0.4 kilograms of particulate matter per megagram of saturated felt or smooth surfaced roll roofing produced.

- Opacity of the exhaust gas from control device shall not exceed 20 percent.
- There shall not be any visible emissions from a saturator capture system for more than a total of 20 percent of the time during any period of consecutive valid observations totaling 60 minutes (modified saturators are exempt from this requirement).

For blowing stills -

- Emissions shall not exceed 0.67 kilograms of particulate matter per megagram of asphalt charged, with a catalyst added to the still and when No. 2 fuel oil or natural gas is fired in the afterburner.
- Emissions shall not exceed 0.71 kilograms of particulate matter per megagram of asphalt charged, with a catalyst added to the still and when No. 6 fuel oil is fired in the afterburner.
- Emissions shall not exceed 0.60 kilograms of particulate matter per megagram of asphalt charged, without an added catalyst and when No. 2 fuel oil or natural gas is fired in the afterburner.
- Emissions shall not exceed 0.64 kilograms of particulate matter per megagram of asphalt charged, without a catalyst and when No. 6 fuel oil is fired in the afterburner.
- Opacity of the exhaust gas from the afterburner shall not exceed 0 percent unless an opacity limit when fuel oil is used in the afterburner has been established by the Administrator (§60.474(k)).

For asphalt storage tanks -

- Exhaust gas opacity not to exceed 0 percent, except for one consecutive 15-minute period in any 24 hours when clearing the transfer lines (the control device may not be bypassed at this time).
- If the storage tank emissions are ducted to the saturator control device, the combined emissions will meet the limit set for the saturator.

For mineral handling and storage facilities -

- Exhaust gas opacity not to exceed 1 percent.

Compliance is demonstrated by an initial performance test using EPA Reference Methods 5A, 9, and 22. The regulation includes monitoring and recordkeeping requirements, which will be discussed in detail in section 2.2.1.4. There are no quarterly reporting requirements.

2.2.1.3. Applicability of the Standards.[4]

2.2.1.3.1. Affected facilities. The affected facilities included in this source category are saturators, mineral handling and storage equipment, asphalt storage tanks, and blowing stills.

A saturator is defined as,

> "the equipment in which asphalt is applied to felt to make asphalt roofing products. The term saturator includes the saturator, wet looper, and coater."

A mineral handling and storage facility is defined as,

> "the areas in asphalt roofing plants in which minerals are unloaded from a carrier, the conveyor transfer points between the carrier and the storage silos, and the storage silos."

An asphalt storage tank is defined as,

> "any tank used to store asphalt at asphalt roofing plants, petroleum refineries, and asphalt processing plants. Storage tanks containing cutback asphalts (asphalts diluted with solvents to reduce viscosity for low temperature applications) and emulsified asphalts (asphalts dispersed in water with an emulsifying agent) are not subject to this regulation."

A blowing still is defined as,

> "the equipment in which air is blown through asphalt flux to change the softening point and penetration rate."

2.2.1.3.2. Applicability date. The NSPS applies only if the construction or modification commenced after November 18, 1980, (the date of the original proposal of the regulation) for any saturator, mineral handling and storage facility, and asphalt storage tank or blowing still that processes and/or stores asphalt used for roofing only or for roofing and other purposes. For any asphalt storage tank or blowing still that processes and/or stores only nonroofing asphalts, the NSPS applies only if the construction, or modification, commenced after May 26, 1981 (the date of the published amendment to the original proposal). The term "commenced" is defined in the General Provisions to 40 CFR 60, (Section 60.2), "Commenced means that an owner or operator has undertaken a continuous program of construction or modification or that an owner or operator has entered into a binding agreement or contractual obligation to undertake and complete, within a reasonable time, a continuous program of construction or modification."

2.2.1.3.3. Modification. While NSPS are intended primarily for newly constructed facilities, existing sources can become subject to an NSPS through either "modification" or "reconstruction." These terms are defined in detail in the General Provisions for Part 60, (40 CFR 60.14 and 40 CFR 60.15).

An existing facility becomes subject to the NSPS under the modification provisions if there is any physical or operational change that causes an increase in the emission rate. A number of clarifications, exemptions, and exceptions to the modification provision are listed. The following actions by themselves are not considered to be modifications:

- routine maintenance, repair, and replacement
- production increases achieved without any capital expenditure
- production increases resulting from an increase in the hours of operation
- use of an alternative fuel if the existing facility was originally designed to accommodate such an alternative use
- addition or replacement of equipment for emission control (as long as the replacement does not increase emissions)
- relocation or change of ownership of an existing facility.

Also, the addition or modification of one facility at a source will not cause other unaltered facilities at that source to become subject to the NSPS.

2.2.1.3.4. Reconstruction. An existing facility becomes subject to the NSPS upon reconstruction regardless of any change in the rate of emissions. Reconstruction is defined as the replacement of components of an existing facility to the extent that the cumulative fixed capital cost of the new components exceeds 50 percent of the cost that would be required to construct a comparable entirely new facility.

2.2.1.4. Testing and Monitoring Requirements.[5] The owner or operator of a facility subject to NSPS is required to conduct performance tests within a specified period after start-up, and thereafter from time to time as may be specified by the EPA. These performance tests are required in order to demonstrate that the standards are being met by the new device. General testing and reporting requirements are listed in the General Provisions for 40 CFR Part 60, (Section 60.7), while testing details specific to this source category are found in Subpart UU, (Section 60.474).

The initial test of performance of a facility must be conducted within 60 days after the facility first achieves its maximum intended rate of operation, but not later than 180 days after the initial startup. Thirty days must be allowed for prior notice to the EPA, to allow the Agency to designate an observer to witness the test.

To demonstrate compliance with the standards limiting the mass of particulate matter per unit of production, EPA Reference Method 5A is used to determine the particulate emissions. Emissions from the saturator are measured while producing 106.6-Kg (235-lb) asphalt shingle if the final product is to be shingle or mineral-surfaced rool roofing, and emissions while producing 6.8-Kg (15-lb) saturated felt will be measured if the final product is to be saturated felt or smooth-surfaced roll roofing. If the final product is only fiberglass shingles, then emissions from the saturator will be measured during the production of 100-Kg (220-lb) shingles. In measuring emissions from blowing stills, the Method 5A test run will be at least 90 minutes, or for the duration of the coating blow, whichever is greater. If the blowing still is not used to blow coating asphalt, the test run will still be 90 minutes or for the duration of the blow, whichever is greater.

EPA Reference Method 9 is used to demonstrate compliance with the opacity regulations. EPA Reference Method 22 is used to determine visible emissions from the saturator capture system (readings are recorded every 15 seconds for a period of consecutive observations totaling 60 minutes during representative conditions).

Continuous monitoring and recording of the following control device temperatures is required:

- the gas at the inlet of any ESP or high velocity air filter
- the combustion zone of any afterburner
- others as determined necessary by the Administrator.

These records must be kept on file for at least two years. These same temperatures are also to be continuously monitored and recorded during the required performance testing, and reported along with the performance test results.

2.2.2. State Regulations.

The State regulations applicable to the asphalt processing and asphalt roofing manufacturing industry are presented in Table 2-1. Both particulate and visible emissions from existing as well as new sources are addressed. For the majority of States, the particulate standard for existing sources is based upon the process weight rate, and is a general regulation covering several industrial processes. For new sources, however, approximately 50% of the States have adopted the NSPS by reference, and several of the others have no specific new source standards (differing from those applicable to existing sources).

TABLE 2-1. State Regulations Applicable to the Asphalt Processing and Asphalt Roofing Manufacturing Industry[6]

State	Existing Sources		New Sources	
	Particulate[a]	Visible[a,b]	Particulate[a]	Visible[a]
Alabama				
- Class 1 Counties	A*	20%	NSPS	NSPS
- Class 2 counties	B*	20%	NSPS	NSPS
Alaska	0.1 grains/scf (prior to 7/1/72)	20%	0.05 grains/scf (after 7/1/72)	N/D
Arizona	B	40%	NSPS	NSPS
Arkansas	A	No. 2 (prior to 1/30/72) No. 1 (after 1/30/72)	NSPS	NSPS
California	None	No. 2	None	N/D
Colorado	A	20%	NSPS	NSPS
Connecticut	None	No. 1 or 20%	None	N/D
Delaware	0.2 grains/scf	No. 1 or 20%	NSPS	NSPS
District of Columbia	0.03 grains/dscf Maximum (see Table 2-2	0%	N/D	N/D
Florida	A	No. 1 or 20%	NSPS	NSPS
Georgia	None	40%	NSPS	NSPS
Hawaii	None	40% (prior to 3/21/72)	None	20% (after 3/21/72)
Idaho	X (prior to 10/1/79)	20%	Y (after 10/1/79)	N/D
Illinois	B	30%	C	N/D
Indiana	B	40%	NSPS	NSPS
Iowa	B	No. 2 or 40%	NSPS	NSPS
Kansas	B	40%	NSPS	NSPS

TABLE 2-1. (continued)

State	Existing Sources		New Sources	
	Particulate[a]	Visible[a,b]	Particulate[a]	Visible[a]
Kentucky	B (or may elect 0.02 grains/scf or control of at least 97%)	40%	NSPS	NSPS
Louisiana	B	20%	N/D	N/D
Maine	A	20%	N/D	N/D
Maryland	For P<30 Tons/hr: See Table 2-2 For P>30 Tons/hr: B or 0.05 grains/dscf (prior to 1/17/72)	20%	0.05 grains/dscf (after 1/17/72)	N/D
- Metropolitan Baltimore and Washington Area	0.03 grains/dscf	0%	N/D	N/D
Massachusetts	For P<30 Tons/hr: See Table 2-2 For P>30 Tons/hr: B	No. 1	1/2 Existing Source Value	N/D
- Critical Areas of Concern	Use 1/2 the value determined above	No. 1	N/D	N/D
Michigan	B	20%	N/D	N/D
Minnesota	A (with a max. of 0.30 grains/scf) (prior to 7/9/69)	20%	N/D	N/D
Mississippi	B (except use equation listed for P<30 tons/hr for all process weight rates)	No. 2 or 40%	NSPS	NSPS
Missouri	B	No. 2	NSPS	NSPS
- Kansas City and St. Louis Metropolitan Areas	B	No. 1	NSPS	NSPS
Montana	B	40% (prior to 11/23/68) 20% (after 11/23/68)	NSPS	NSPS

TABLE 2-1. (Continued)

State	Existing Sources		New Sources	
	Particulate[a]	Visible[a,b]	Particulate[a]	Visible[a]
Nebraska	B	No. 1 or 20%	NSPS	NSPS
Nevada	B*	20%	N/D	N/D
New Hampshire	G (prior to 2/18/72)	20%	B (after 2/18/72)	N/D
New Jersey	See Table 2-3	20%	N/D	N/D
New Mexico	None	20%	NSPS	NSPS
New York	None (prior to 7/1/73)	20%	Table 2-4 (after 7/1/73)	N/D
North Carolina	B	40% (prior to 7/1/71) 20% (after 7/1/71)	NSPS	NSPS
North Dakota	B	40%	N/D	20%
Ohio	B	20%	N/D	N/D
Oklahoma	B	20%	N/D	N/D
Oregon	For P<30 Tons/hr: See Table 2-2 For P>30 Tons/hr: B	40% (prior to 6/1/70) 20% (after 6/1/70)	NSPS	NSPS
Pennsylvania	Z	20%	NSPS	NSPS
Rhode Island	B	20%	N/D	N/D
South Carolina	B	40% (prior to 12/31/85)	N/D	20% (after 12/31/85)
South Dakota	B	20%	N/D	N/D
Tennessee	B (prior to 4/3/72)	No. 2 or 40% (prior to 4/3/72)	A (after 4/3/72)	No. 1 or 20% (after 4/3/72)
Texas	Q	30% (prior to 1/31/72)	N/D	20% (after 1/31/72)
Utah	None	40% (prior to 4/25/71)	None	20% (after 4/25/71)

TABLE 2-1. (Continued)

State	Existing Sources		New Sources	
	Particulate[a]	Visible[a,b]	Particulate[a]	Visible[a]
Vermont	See Table 2-2	40% (prior to 4/30/70)	N/D	20% (after 4/30/70)
Virginia	B	20%	NSPS	NSPS
- AQCR 7	See Table 2-2	20%	NSPS	NSPS
Washington	0.23 grams/dscm	20%	NSPS	NSPS
West Virginia	See Table 2-5	20%	NSPS	NSPS
Wisconsin	0.4 lbs. particulate per 1000 lbs. exhaust gas (prior to 4/1/72) A* (after 4/1/72)	No. 2 or 40% (prior to 4/1/72) No. 1 or 20% (after 4/1/72)	NSPS	NSPS
- Subregion 1 of Lake Michigan Intrastate AQCR or S.E. Wisconsin Intrastate AQCR	0.4 lbs. particulate per 1000 lbs. exhaust gas (prior to 4/1/72) A* (after 4/1/72)	No. 1 or 20%	NSPS	NSPS
Wyoming	B	20%	NSPS	NSPS

[a] All "priors" or "afters" mean the facility was in operation prior to or after that date.
[b] Numbers rather than percentages (ex. = No. 1) refer to the Standard or Ringelmann Smoke Charts.

TABLE 2-1. KEY

A	$E = 3.59\ P^{0.62}$	$P < 30$ tons/hr
	$E = 17.31\ P^{0.16}$	$P \geq 30$ tons/hr
A*	$E = 3.59\ P^{0.62}$	$P < 30$ tons/hr
	$E = 17.31\ P^{0.16}$	$P \geq 30$ tons/hr
B	$E = 4.1\ P^{0.67}$	$P < 30$ tons/hr
	$E = 55.0\ (P^{0.11}) - 40$	$P \geq 30$ tons/hr
B*	$E = 4.1\ P^{0.67}$	$P < 30$ tons/hr
	$E = 55.0\ (P^{0.11}) - 40$	$P \geq 30$ tons/hr
C	$E = 2.54\ P^{0.534}$	$P < 450$ tons/hr
	$E = 24.8\ P^{0.16}$	$P \geq 450$ tons/hr
G	$E = 5.05\ P^{0.67}$	$P < 30$ tons/hr
	$E = 66.0\ (P^{0.11}) - 46$	$P \geq 30$ tons/hr
Q	$E = 0.48\ q^{0.62}$	
X	$E = 0.045\ PW^{0.60}$	$PW < 17{,}000$ lbs/hr
	$E = 1.12\ PW^{0.27}$	$PW \geq 17{,}000$ lbs/hr
Y	$E = 0.045\ PW^{0.60}$	$PW < 9{,}250$ lbs/hr
	$E = 1.10\ PW^{0.25}$	$PW \geq 9{,}250$ lbs/hr
Z	$E = 0.76\ (0.6\ PA)^{0.42}$	

E = Emission rate in lbs/hr
P = Process weight rate in tons/hr
q = Stack effluent flow rate in acfm
PW = Process weight rate in lbs/hr
PA = Tons asphalt used/hr
N/D = No specific new source standard differing from existing
NSPS = Adopted the NSPS by reference

TABLE 2-2. PROCESS WEIGHT REGULATIONS FOR DISTRICT OF COLUMBIA, MARYLAND, MASSACHUSETTS,$_7$OREGON, VERMONT, VIRGINIA ACQR7[7]

Process Weight Per Hour in Pounds	Maximum Weight of Particulate Discharge Per Hour in Pounds	Process Weight Per Hour in Pounds	Maximum Weight of Particulate Discharge Per Hour in Pounds
50	.24	3400	5.44
100	.46	3500	5.52
150	.66	3600	5.61
200	.85	3700	5.69
250	1.03	3800	5.77
300	1.20	3900	5.85
350	1.35	4000	5.93
400	1.50	4100	6.01
450	1.63	4200	6.08
500	1.77	4300	6.15
550	1.89	4400	6.22
600	2.01	4500	6.30
650	2.12	4600	6.37
700	2.24	4700	6.45
750	2.34	4800	6.52
800	2.43	4900	6.60
850	2.53	5000	6.67
900	2.62	5500	7.03
950	2.72	6000	7.37
1000	2.80	6500	7.71
1100	2.97	7000	8.05
1200	3.12	7500	8.39
1300	3.26	8000	8.71
1400	3.40	8500	9.03
1500	3.54	9000	9.36
1600	3.66	9500	9.67
1700	3.79	10000	10.0
1800	3.91	11000	10.63
1900	4.03	12000	11.28
2000	4.14	13000	11.89
2100	4.24	14000	12.50
2200	4.34	15000	13.13
2300	4.44	16000	13.74
2400	4.55	17000	14.36
2500	4.64	18000	14.97
2600	4.76	19000	15.58
2700	4.84	20000	16.19
2800	4.92	30000	22.22
2900	5.02	40000	28.3
3000	5.10	50000	34.3
3100	5.18	60000	40.0
3200	5.27	or	
3300	5.36	more	

* Where the process weight per hour falls between two values in the table, the maximum weight per hour shall be determined by linear interpolation.

TABLE 2-3. EMISSION RATES FOR NEW JERSEY[8]

MAXIMUM ALLOWABLE EMISSION RATE FOR PARTICLES

1 Potential emission rate from source operation (lbs. per hr.)	2 Allowable emission rate (lbs. per hr.) (Based on 99% efficiency of collection)	3 Source gas emitted from source (Standard cu. ft. per min.)	4 Allowable emission rate (lbs. per hr.) (Based on 0.02 gains per SCF)
50 or less	00.5	3,000 or less	0.5
100	01.0	6,000	1.0
1000	10.0	35,000	6.0
2000	20.0	70,000	12.0
3000 or greater	30.0	140,000	24.0
		175,000 or greater	30.0

INSTRUCTIONS

1. From columns 1 and 2 above, determine the allowable emission rate based upon the potential emission rate of solid particles from the source operation as measured by the performance test principles set forth in subsections 3(a) and 3(b) of this Subchapter.

2. From columns 3 and 4 above, determine the allowable emission rate based upon the source gas emitted from the source operation. Whenever dilution gas is, for any purpose, added to the source gas from a source operation, the source gas emitted shall be considered to be the gas discharge rate prior to such dilution.

3. The greater of the two emission rates as determined from 1 and 2 above shall be the maximum allowable emission rate. For rates between any two consecutive values stated in columns 1 and 3, the corresponding allowable emission rates shall be as determined by interpolation.

TABLE 2-4. EMISSION RATES FOR NEW YORK[9]

ENVIRONMENTAL RATING

Rating	*Criteria*
A	An air contaminant whose discharge results, or may result, in serious adverse effects on receptors or the environment. These effects may be of a health, economic or aesthetic nature or any combination of these.
B	An air contaminant whose discharge results, or may result in only moderate and essentially localized effects; or where the multiplicity of sources of the contaminant in any given area require an overall reduction of the atmospheric burden of that contaminant.
C	An air contaminant whose discharge may result in localized adverse effects of an aesthetic or nuisance nature.
D	An air contaminant whose discharge will not result in measurable or observable effects on receptors, nor add to an existing or predictable atmospheric burden of that contaminant which may cause adverse effects, considering properties and concentrations of the emissions, isolated conditions, stack height and other factors.

The following items will be considered in making a determination of the environmental rating to be applied to an air contaminant:

Rating	*Criteria*
(a)	toxic and other properties and emission rate potential of the air contaminant;
(b)	location of the source with respect to residences or other sensitive environmental receptors, including a consideration of the area's anticipated growth;
(c)	emission dispersion characteristics at or near the source, taking into account the physical location of the source relative to surrounding buildings and terrain; and
(d)	the projected maximum cumulative impact of taking into account emissions from all sources in the facility under review and the preexisting ambient concentration of the air contaminant under review.

Degree of Air Cleaning Required
for
Gases and Liquid Particulate Emissions (Environmental Rating A, B, C or D)
and
Solid Particulate Emissions (Environmental Rating A or D)

EMISSION RATE POTENTIAL (LB/HR)

Environmental rating	*Less than 1.0*	*1 to 10*	*10 to 20*	*20 to 100*	*100 to 500*	*500 to 1,000*	*1,000 to 1,500*	*1,500 to 4,000*	*4,000 to 10,000*	*10,000 and greater*
A	**	99% OR GREATER OR BEST AVAILABLE CONTROL TECHNOLOGY								
B	**		90%	91%	94%	96%		97%	98%	99% or greater
C	**		70%	75%	85%	90%		93%	95%	98% or greater
D	NO AIR CLEANING REQUIRED									

** Degree of air cleaning required shall be specified by the commissioner.

For solid particulate emissions with an environmental rating of B or C, no person will cause or allow emissions that exceed 0.050 grains/dscf.

TABLE 2-5. EMISSION RATES FOR WEST VIRGINIA[10]

Operating Source Operation or Total Duplicate Source Operation Process Weight Rate in Pounds per Hour[1]	Maximum Allowable Total Stack Emission Rate in Pounds per Hour for the Appropriate Process Weight and Source Operation Type.			
	Type 'a'	Type 'b'	Type 'c'	Type 'd'
0	0	0	0	0
2,500	3	3	9	0.2
5,000	5	5	13	0.8
10,000	10	10	19	1.8
20,000	16	16	26	4.0
30,000	22	22	32	6.2
40,000	28	28	36	8.3
50,000	31	31	40	10.5
100,000	33	33	54	21.2
200,000	37	37	70	21.2
300,000	40	40	80	21.2
400,000	43	45	88	21.2
500,000	47	53	94	21.2
600,000	50	62	99	21.2
700,000	50	71	99	21.2
800,000	50	79	99	21.2
900,000	50	88	99	21.2
1,800,000 and above	50	176	99	21.2

[1] For a process weight between any two consecutive process weights stated in this table the emission limitation shall be determined by linear interpolation.

(a) Type 'a' shall mean any manufacturing process source operation involving glass melting, calcination or physical change except as noted in Type 'c' below.

(b) Type 'b' shall mean any metallurgical manufacturing process source operation. Gray iron cupolas located in the counties of Brooke, Hancock, Ohio, Marshall, and Kanawha; and the Magisterial Districts of Valley (Fayette County), Scott and Pocatalico (Putnam County), Tygart (Wood County), and Union and Winfield (Marion County west of I-79) shall be classified as Type 'b' source operations.

(c) Type 'c' shall mean any wet cement manufacturing process source operation which is used for the primary purpose of calcination. Gray iron cupolas located in the areas of the state other than those defined in Subsection 1.22(b) shall be classified as Type 'c' source operations.

(d) Type 'd' shall mean any manufacturing process source operation in which materials of any origin undergo a chemical change unless otherwise classified.

2.3 REFERENCES

1. Clean Air Act As Amended, August 1977. 42 U.S.C. Title I -- Air Pollution Prevention and Control. Part A -- Air Quality and Emission Limitations; Section 111 -- Standards of Performance for New Stationary Sources. Washington, DC.

2. Reference 1, Section 114 -- Inspections, Monitoring, and Entry.

3. Reference 1.

4. U.S. Environmental Protection Agency. *Code of Federal Regulations. Title 40, Part 60.* Office of the Federal Register. Washington, DC July 1, 1985.

5. Reference 4.

6. Bureau of National Affairs, Inc., Environment Reporter - State Air Laws.

7. Reference 6.

8. Reference 6.

9. Reference 6.

10. Reference 6.

3.0 THE ASPHALT ROOFING INDUSTRY

3.1 INTRODUCTION

Several products are produced at asphalt roofing plants. These include; shingles (used predominantly for residential roofing), roll roofing (smooth or mineral surfaced), ply felt (used in commercial built-up roofs), and saturated felt (used as shingle underlayment). Until recently, both ply felt and saturated felt were categorized as saturated felt.

The production of asphalt roofing begins with a dry base webbing, composed of either organic cellulose fiber felt, or inorganic fiberglass mat. The webbing is then saturated and/or coated with asphalt and, if appropriate for the product being produced, surfaced with selected mineral aggregates. When using the inorganic webbing, the saturation step is bypassed.

Much of the usefulness and durability of asphalt roofing products can be attributed to the waterproofing characteristics of the asphalt. The saturant and coating asphalts used in the production process begin with an asphalt flux, which is usually a blend of crude oil residuum from the refining process. Air is then blown through the hot asphalt flux to raise the temperature at which it will soften. The stabilized coating asphalt is then prepared by mixing coating asphalt and a mineral stabilizer in approximately equal proportions.

Since the establishment of the NSPS for the asphalt roofing industry, a new product, modified bitumen membrane, is being produced. The product consists of a polyester or fiberglass web impregnated with an asphalt/polymer mixture, and occasionally surfaced with granules.

3.2 PROCESSES AND THEIR EMISSIONS

3.2.1 Processes[1]

The processes which contribute to emissions from asphalt roofing manufacturing can be placed in three broad categories. These are:

1. the roofing manufacturing line;
2. the delivery, transfer, and storage of materials used in the manufacture of roofing products; and
3. the processing (blowing) of asphalt to place it in a form suitable for use in roofing products.

3.2.1.1 Roofing Manufacturing Line. The sequence of events in the roofing manufacturing line is illustrated by the block diagram of Figure 3-1 and the flow diagrams of Figures 3-2 and 3-3. Figure 3-3 also indicates some of the ancillary activities necessary to the line operation. Each of the line activities is described below.

- Dry looper: A roll of base webbing is installed on the reel and unwound onto the dry floating looper. The dry floating looper provides a reservoir of web material to match the intermittent operation of the roller to the continuous operation of the line. There are no significant emissions generated in this process step.

Following the dry looper, organic products proceed to the next two pieces of line equipment; saturator and wet looper. Inorganic products (those with a fiberglass mat base web) bypass these two operations, and proceed directly to the coater. The porous construction of the fiberglass mat permits it to be completely permeated by the stabilized coating asphalt, obviating the need for a separate saturation step.

- Saturator: Following the dry looper, the organic felt web enters the saturator where moisture is driven out and the felt fibers and intervening spaces are filled with "saturant" asphalt. The saturator also contains a looper arrangement which is almost totally submerged in a tank of asphalt maintained at a temperature of 232° to 260°C (450° to 500°F). The absorbed asphalt increases the sheet or web weight by about 150 percent. At some plants the felt is sprayed on one side with asphalt to drive out the moisture prior to dipping. This approach reportedly results in higher emissions than does use of the dip process alone. The saturator is a significant emission source of organic particulate.

- Wet looper: The saturated organic felt web then passes through drying-in drums and onto the wet looper, sometimes called the hot looper. The drying-in drums press surface saturant into the felt.

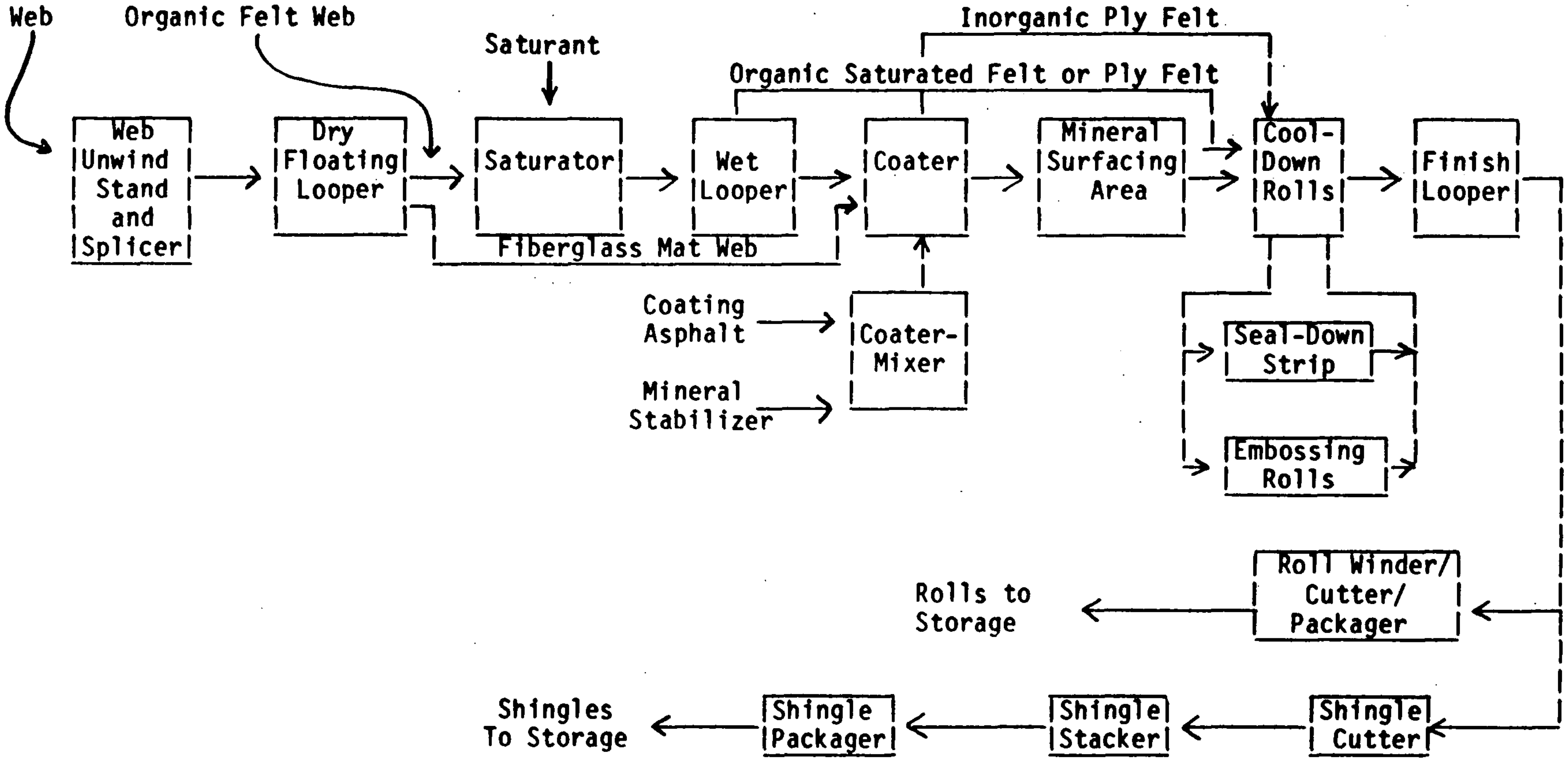


Figure 3-1. Block diagram asphalt roofing line.

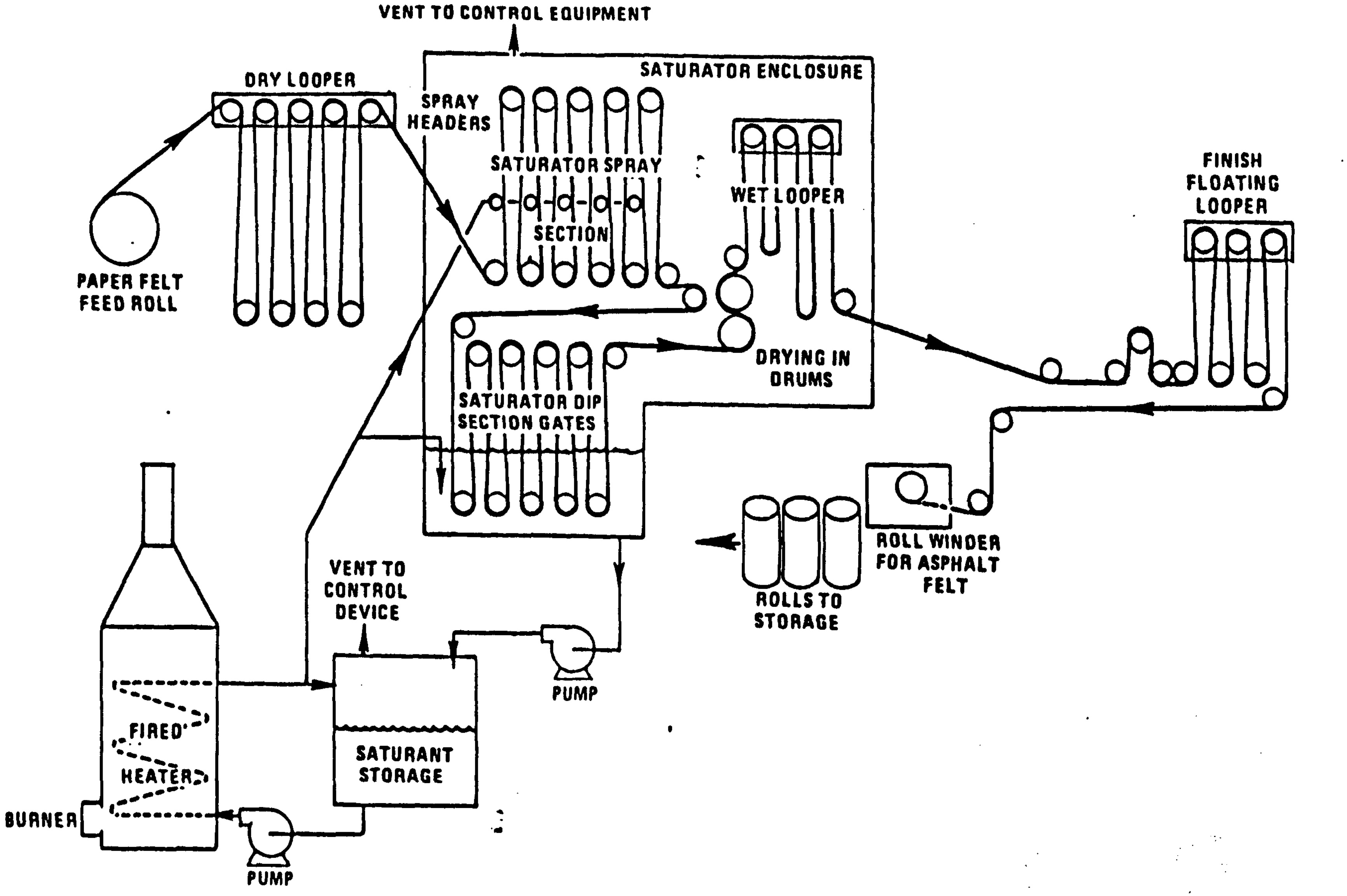
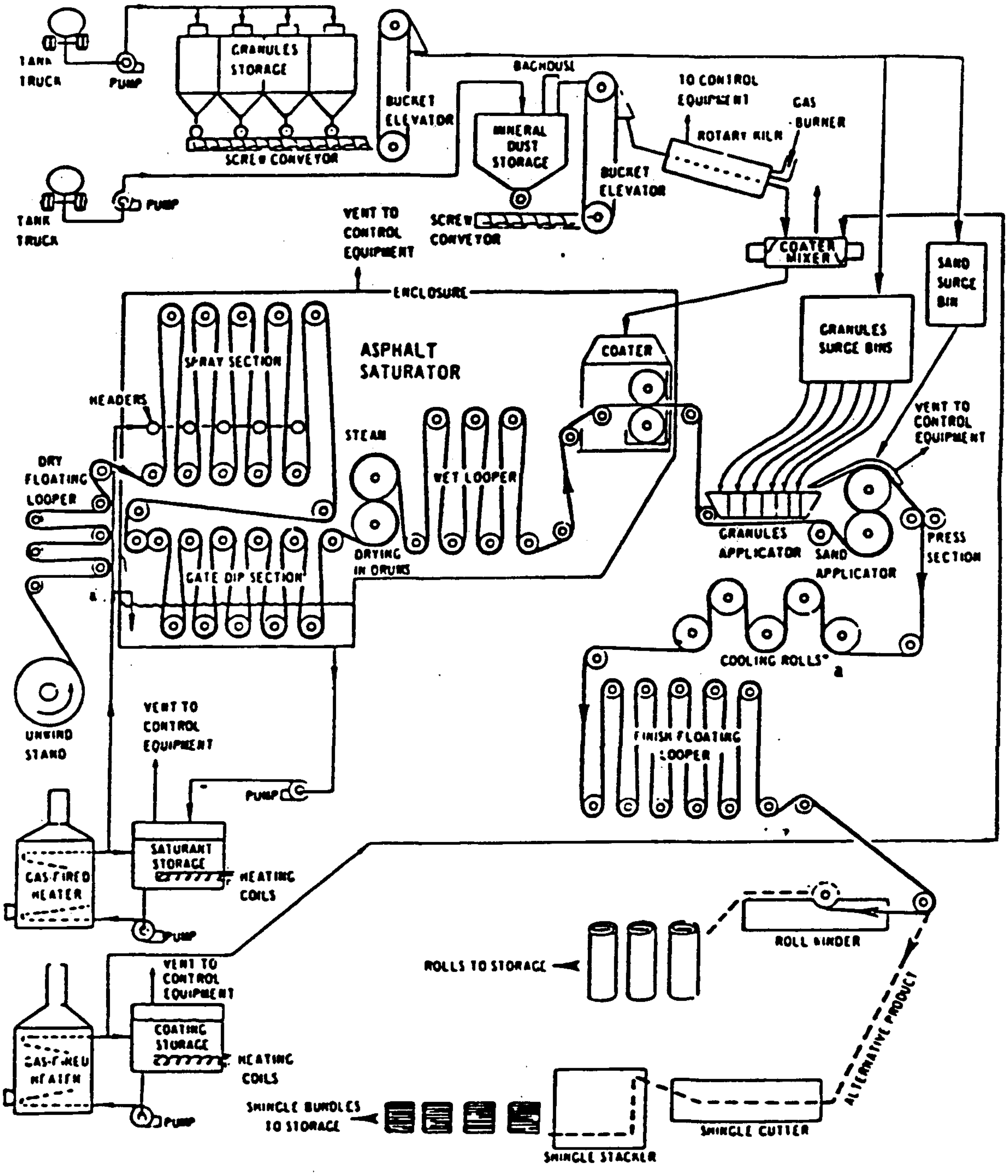


Figure 3-2. Typical flow diagram for production of saturated felt.[2]



[a] = WATER SPRAY USED ALSO. THIS IS FOLLOWED BY "SEAL-DOWN" STRIP APPLICATION.

Figure 3-3. Typical flow sheet for the manufacturing of organic shingles and rolls.[3]

Sometimes additional saturant is also added at this point. The amount of absorption depends on the viscocity of the asphalt and the length of time the asphalt remains fluid. The wet looper increases absorption by providing time for the saturant asphalt to penetrate the felt. Emissions from the wet looper consist of organic particulate. The wet looper is a significant emission source of organic particulate.

If organic saturated felt or ply felt is being produced, the organic sheet bypasses the next two steps (coating and surfacing) and passes directly to the cool-down section. For organic surfaced roofing products, however, the saturated felt proceeds to the coater. During the production of inorganic products, the dry fiberglass mat webbing proceeds directly from the dry looper to the coater to be "filled" with asphalt.

- Coater: The coater employs a roller type system to apply a stabilized asphalt to both the top and bottom surfaces of the webbing sheet. Stabilized coating contains a harder, more viscous asphalt which has a higher softening point than saturant asphalt and a mineral stabilizer. The coating asphalt and mineral stabilizer are mixed in approximately equal proportions. The mineral stabilizer may consist of finely divided lime, silica, slate dust, dolomite, or other mineral materials. The softening point of saturant asphalts varies from 40° to 74°C (104° to 165°F) whereas the softening point of coating asphalt varies from 99° to 116°C (210° to 240°F). The weight of the finished product is controlled by the amount of coating used. The coater rollers can be moved closer together to reduce the amount of coating applied to the felt, or separated to increase it. Many modern plants are equipped with automatic scales or profile scanners which monitor the sheets in the process of manufacture and warn the coater operator when the product is running under or over specifications. The coater is a significant emission source, releasing asphalt fumes containing organic particulate.

- Coater-mixer: The function of the coater-mixer, which is usually positioned over the line at the coater, is to mix coating asphalt and a mineral stabilizer in approximately equal proportions. The stabilized asphalt is then piped down to the coating pan. The asphalt is piped in at about 232° to 260°C (450° to 500°F), and the mineral stabilizer is delivered by screw conveyor. There is often a preheater immediately ahead of the coater-mixer to dry and preheat the material before it is fed into the coater-mixer. This eliminates moisture problems and also helps to maintain the temperature above 160°C (320°F) in the coater-mixer. The emissions from the preheater are vented to a baghouse at some plants. The coater-mixer is usually covered or enclosed, with an exhaust pipe for the air displaced by (or carried with) the incoming materials. Emissions from the coater-mixer include both organic and inorganic particulate, but are expected to be primarily inorganic. The emissions from the coater-mixer are not as significant as the emissions from the saturator and coater.

If inorganic ply felt is being produced, the fiberglass sheet by-passes the next step (surfacing) and proceeds to the cool-down section. Both organic and inorganic surfaced products [smooth surfaced rolls (base ply), mineral surfaced rolls (cap sheets), and shingles] proceed to the surfacing section of the manufacturing line.

- Mineral surfacing: The surfacing section of the roofing line usually consists of a multi-compartmented granule hopper, two parting agent hoppers, and two large press rollers (see Figure 3-4). The hoppers are fed through flexible hoses from one or more machine bins above the line. These machine bins provide temporary storage and are sometimes called surge bins. The granule hopper drops colored granules from its various compartments onto the top surface of the moving sheet of coated webbing in the sequence necessary to produce the desired color pattern on the roofing. This step is bypassed for smooth-surfaced products. Potential emission sources are the machine bin, the granule hopper, and the hopper/sheet

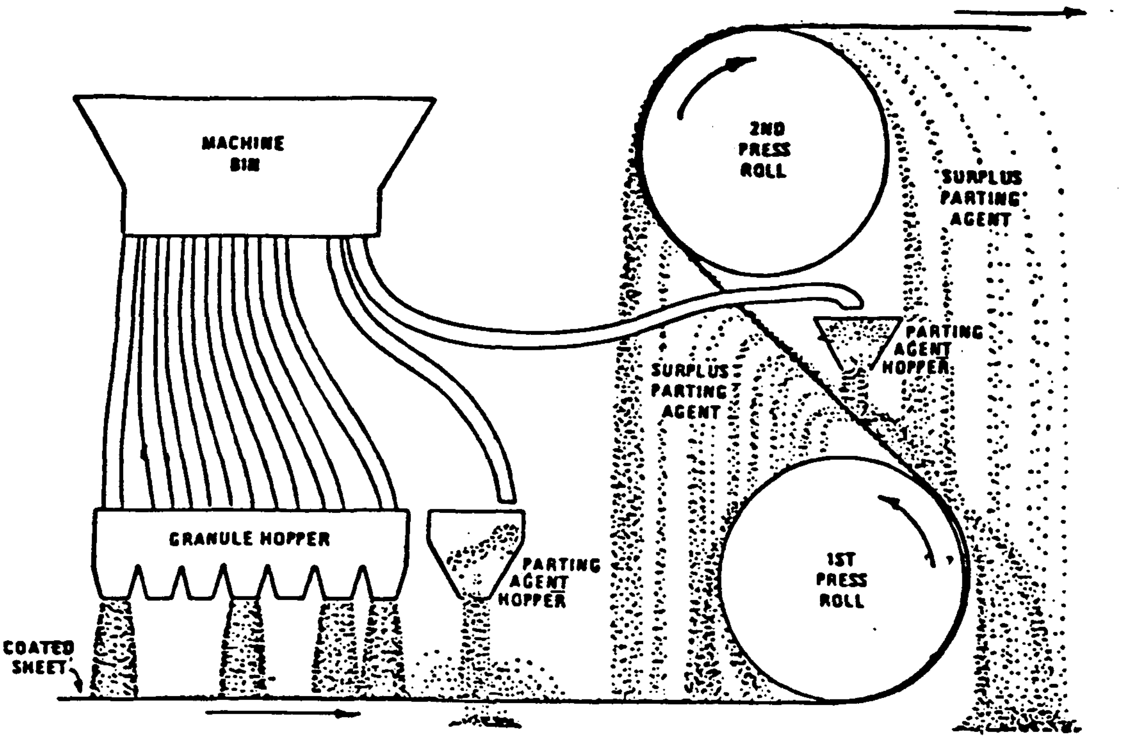


Figure 3-4. Surfacing section of typical asphalt roofing manufacturing line.[4]

interface. At those plants visited when developing the original NSPS, emissions from the granule surfacing operation appeared to be minimal, even though no attempt was made at control. Granules are usually dyed or oiled, which could account for the low level of observed emissions. Parting agents such as talc and sand (or some combination thereof) are applied from parting agent hoppers to the top and back surfaces of the coated sheet. The first hopper drops a generous amount of parting agent onto the top surface of the coated sheet and slightly over each edge. Collectors are often placed at the edges of the sheet to pick up this overspray, which is then recycled to the parting agent machine bin by open screw conveyor and bucket elevator. Emission sources are the machine bin (which is usually covered), the open hopper, the hopper/sheet interface, and the roofing sheet. The last two sources are the most significant. If excess material is recycled, the equipment involved (screw conveyor, bucket elevator etc.) is also a potential emission source. Because of the steep angle of the sheet at this point, the average fall distance from the hopper to the sheet is usually somewhat greater than on the top side, and more of the material falls off the sheet. Talc or sand is usually applied to both sides when smooth rool roofing is being made. When manufacturing mineral-surfaced products, granules of the proper color combinations are added as described above from hoppers and the back is coated with talc or sand. Consequently, in the manufacture of mineral-surfaced products, the coating of the back side with the finely divided talc or sand would be a greater source of dust than that from mineral surfacing. Another method sometimes used to apply backing agent to the back side of the sheet is shown in Figure 3-5. In this technique, a hinged trough holds the backing material against the sheet, which picks up only what will stick to it. When the line is not operating, the trough is tipped back so that no parting agent will escape past its lower lip. Emissions when this application technique is used appear to be considerably lower in magnitude than with the gravity dusting technique.

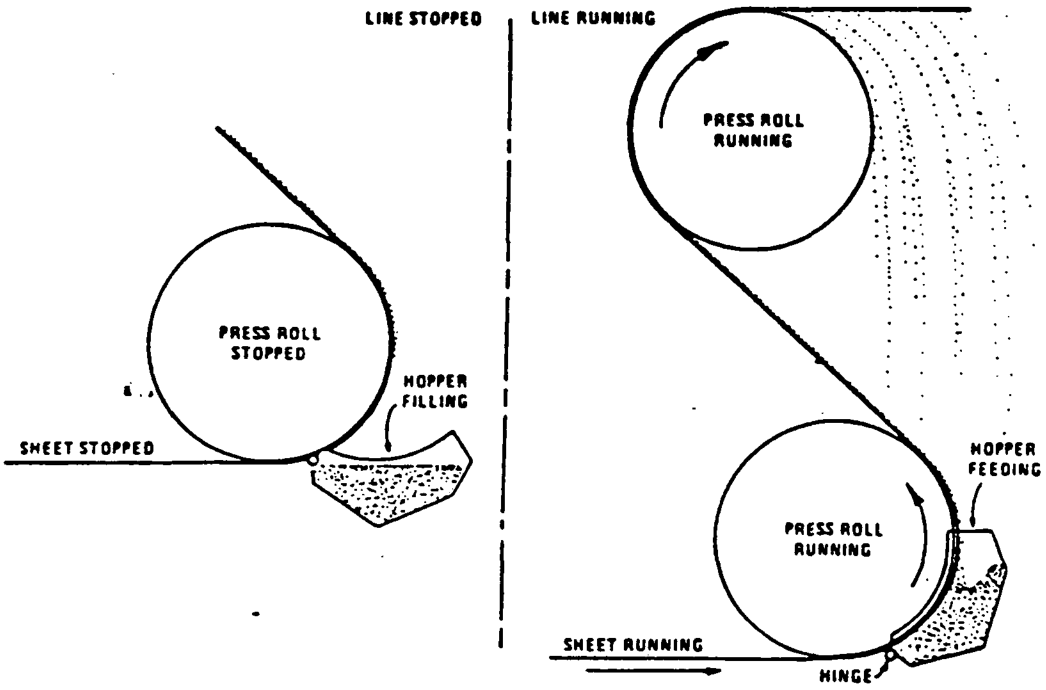


Figure 3-5. Alternative method for applying parting agent.[5]

- Product cooling and seal-down strip application: All roofing products pass through this portion of the manufacturing line. In this section, the sheet is cooled rapidly by passing it around water-cooled rollers in an abbreviated looper arrangement. Usually, water is also sprayed on the surfaces of the sheet to speed this cooling process. Emissions from this section were not measured during the original NSPS development program, but where water sprays are used, are expected to be mostly water vapor with some mineral particulate. These emissions are usually expelled to the atmosphere with the aid of large, wall- or roof-mounted fans. The asphalt seal-down strip is usually applied to the selfsealing coated roofings in this section by a roller partially submerged in a pan of hot sealant asphalt. This pan is usually covered and fugitive emissions appeared to be minimal at the plant surveyed during the original NSPS development program. Some products are also texturized at this point by passing the sheet over an embossing roll which forms a pattern in the surface of the sheet.

- Finish or cooling looper: The purpose of this section is twofold; first, it allows the product to cool and dry off gradually, and, second, the finish looper serves as an accumulator to match the continuous operation of the line to the intermittent operation of the roll winder. It also allows time for quick repairs or adjustments to the shingle cutter and stacker during continuous line operation or, conversely, allows cutting and packaging to continue when the line is down for repair. Usually this section is enclosed to keep the final cooling process from progressing too rapidly. Sometimes, in cold weather, heated air is also used to retard cooling. The sheet is relatively cool at this point; therefore, emissions are not expected to be significant.

- Cutting and packaging: Sheet destined for roll goods is wound on a mandrel, cut to the proper length, and packaged. When shingles are being made, the material from the finish looper is fed into the shingle cut machine. After the shingels have been cut, they are moved by roller conveyor to automatic packaging equipment or, in some plants, are manually packaged. They are then stacked on pallets and transferred by fork lift to storage areas or waiting trucks. Emissions from the cutting and packaging operations were not measured during the original NSPS development program, but are not expected to be significant.

Additional steps, which may be conducted off-line, are required for some specialty shingles (such as laminated and multilayered products).

3.2.1.2 New Processes.[6, 7] The production of modified bitumen membrane is becoming an increasing portion of the asphalt roofing industry. This product is generally used for single-ply commercial roofs, or as a waterproofing material, and currently holds approximately 9 percent of the commercial roofing market.[8] A block diagram of the modified bitumen production line is shown in Figure 3-6.

The first step of the modified bitumen production process is the mixing of the asphalt with atactic and isotactic polypropylene, or styrene-butadiene-styrene, and a mineral stabilizer in large heated tanks (356°F or 180°C). This mixture is then applied to a polyester or fiberglass mat base webbing. The "impregnation vat" consists of a looper type arrangement in a shallow vat of the asphalt mixture, followed by a set of rollers to meter the thickness of the product. The sheet begins the cooling process by floating on a water filled tray while either granules or a polypropylene backing sheet are applied to the top side (which is still hot). The sheet is then either completely submerged in another water filled tray or sprayed with water to finish the cooling process. After the sheet is dried with a fan, talc is applied to the unsurfaced side as a parting agent. The sheet then passes through a finish looper (accumulator) and is wound on rolls. Emissions from modified bitumen production include particulate and gaseous hydrocarbons from the mixing tanks and impregnation vats, and inorganic particulate from mineral handling and storage.

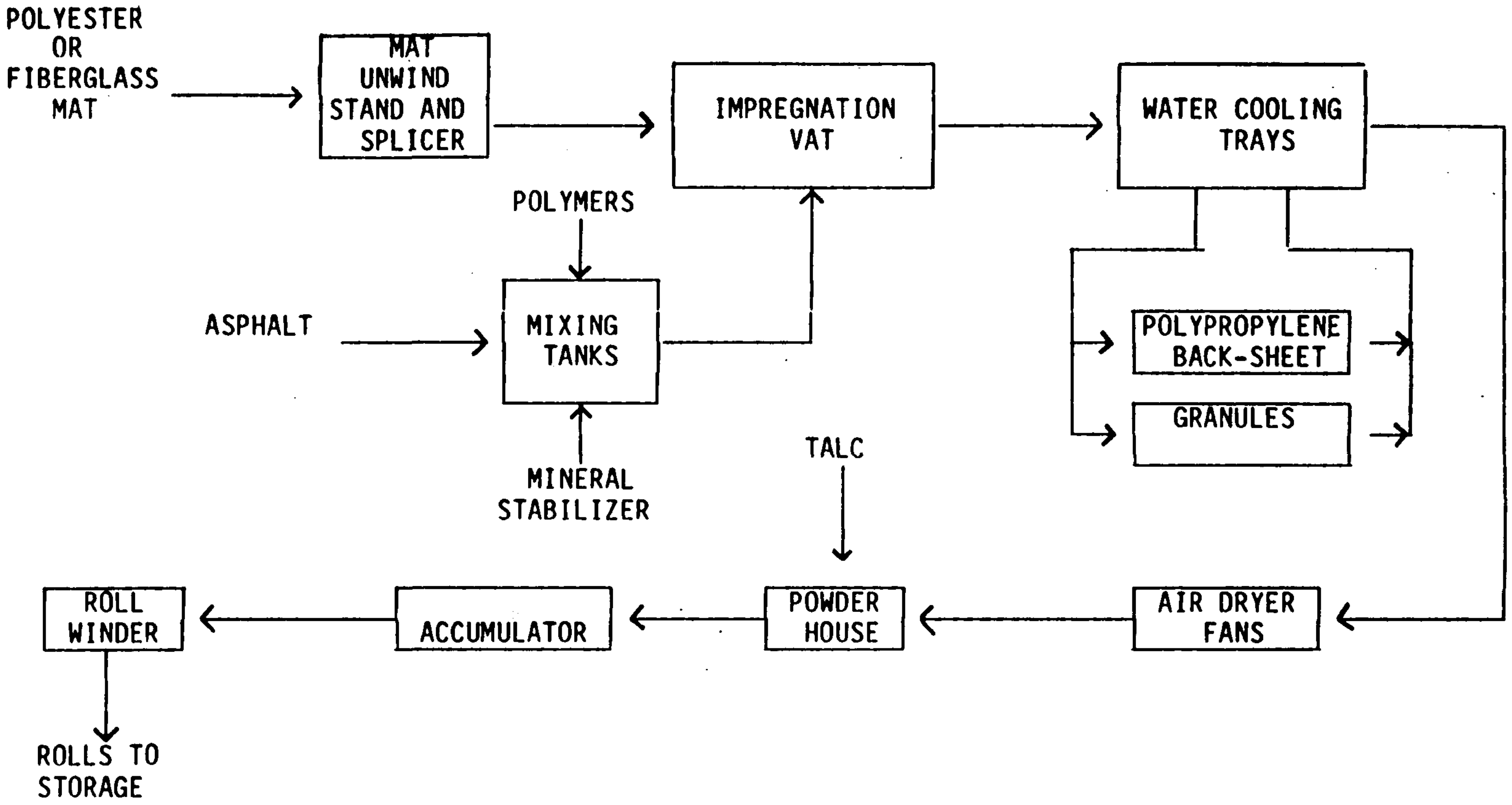


FIGURE 3-6. BLOCK DIAGRAM MODIFIED BITUMEN PRODUCTION LINE.

3.2.1.3 Materials Delivery, Transfer, and Storage[9]

3.2.1.3.1 Asphalt supply. The asphaltic material used to make roofing grades of asphalt known as "saturant" and "coating asphalt" is obtained from the petroleum industry. It is a product of the fractional distillation of crude oil that occurs toward the end of the distilling process and is commonly known as asphalt flux. Asphalt flux is sometimes blown by the oil refiner or asphalt processor to meet the roofing manufacturer's specifications. Many roofing manufacturers, however, purchase the flux and carry out their own blowing. Asphalt fumes, composed of gaseous HC and organic particulate, can also be released during asphalt transfer and storage.

Asphalt is normally delivered to the asphalt roofing plant in bulk by pipeline, tanker truck, or railcar. Bulk asphalts are delivered in liquid form at temperatures of 93° to 204°C (200° to 400°F), depending on the type of asphalt and local practice. Coating asphalts, however, can also be delivered in solid form.

Several tanker unloading techniques are used. The most common method is to couple a flexible pipe to the tanker and pump the asphalt directly into the appropriate storage tanks. The tanker cover is partially open during the transfer. The potential sources of emissions are the tanker and the storage tanks. The magnitude of the emissions from the tanker is at least partially dependent on how far the cover is opened. Another unloading procedure, of which there are numerous variations, is to pump the hot asphalt into a large open funnel which is connected to a surge tank. From there, asphalt is pumped into storage tanks. Emission sources are the tanker, the interface between the tanker and the surge tank, the surge tank, and the storage tanks. The emissions from these sources are organic particulate. The quantity of emissions depends on the asphalt temperature and on the asphalt characteristics.

Asphalt flux is usually stored at 51° to 79°C (124° to 174°F), although storage temperatures of up to 232°C (450°F) have been noted. The temperature is usually maintained with steam coils in the tanks at the lower temperatures. [Oil- or gas-fired preheaters are used to maintain the asphalt flux at temperatures above 93°C (200°F).] Saturant and coating asphalt are normally stored at 204° to 260°C (400° to 500°F). Temperatures are maintained by heating the tanks directly or by cycling the asphalt through external heat exchangers, usually of the closed tube type. Asphalt is transferred within the plant by closed pipeline. Barring leaks, the only potential emission sources are the end-points. These end-points are the storage tanks, the asphalt heaters (if not the closed tube type), the blowing stills, the coater-mixers, and the saturator and coater pans.

Coating asphalt delivered in solid form is stored in open-ended cardboard tubes or metal cans until needed for use. It must be melted and heated to operating temperature prior to transfer. This is usually accomplished in open kettles which discharge fumes into the building. Remelted filled coating asphalt is piped directly from the kettle to the coater pan while unfilled coating asphalt is transferred to the coater-mixer and then to the coater pan. For filled asphalt, the emission sources are the kettle and the coater pan. For unfilled asphalt, there is one additional emission source, the coater-mixer.

In the case of asphalt prepared for shipment elsewhere, emission sources vary with the type of product and the manner of shipment. As with in-plant transfers, potential sources of emissions are from end-points of pipeline transfers of flux, saturant, and unfilled coating asphalt. These are the sending and receiving storage tanks. Tanker trucks and railcars are loaded by direct coupling to the transfer tanks and loaded with the tanker manhole covers open. Emission sources are the transfer tanks and the tanker. The methods used for preparing solid asphalt and asphalt emulsions for delivery are not included in this program.

3.2.1.3.2 Mineral product supply. The supply of mineral products to the surfacing area of the roofing line and to the coater-mixer involves the unloading, storage, and transfer of the following products:

1. granules;
2. parting agent (talc or sand); and
3. mineral stabilizer (limestone, traprock, dolomite, slate).

Granules are generally procured in an oiled or coated (painted or dyed) state and are essentially dust-free. Granule sizes vary, depending on the product being produced, but a typical specification allows only 2 percent to be smaller than 420 um.

Sand is a sharp silica or similar fine material which is normally procured free of dirt, loam, and other foreign material. A typical specification requires that 100 percent pass through a U.S. Standard No. 8 screen (230 um), 20 to 40 percent pass through a No. 100 screen (149 um), and 0 to 5 percent pass through a No. 200 screen (74 um).

Talc can be micaceous or foliated and is generally purchased free of dirt and any foreign material. The average particle size is quite small, with a typical specification requiring that 30 to 36 percent pass through a 200-mesh (74-um) screen.

Mineral stabilizer is a fine, inorganic material such as dolomite, micaceous materials, slate, limestone, or trap rock. It can also be a mixture of several of these materials since material captured in baghouses is recycled at many plants for use as stabilizer. One specification requires that at least 60 percent of the mineral stabilizer pass through a 200-mesh (74-um) screen.

3.2.1.3.3 Unloading and storage. Rock granules are normally delivered in bulk by hopper railcar or truck and dumped onto an underground belt conveyor. They are then transported by bucket elevator, belt conveyor, or gravity feed pipe to the appropriate silo or storage bin. Potential sources of fugitive emissions are the vehicle hopper/conveyor bin interface, any above-ground belt conveyors, all material transfer points, and the silos or storage bins if not covered. The underground conveyors, being fully enclosed, are not emission sources. Most plants do not enclose or ventilate these sources to control emissions. If granules are procured and maintained dust-free, emissions should be minimal during these operations.

Granules are unloaded pneumatically at some plants. In this technique, material is transported from the truck (or railcar) to the silo while it is entrained in a column of air. Both negative and positive pressure systems are used, although the positive pressure system is more common. Pneumatic transfer can generate more dust from the granules. However, since it is a closed system, the only source of fugitive emissions is the discharge into the silo. Some rarely used specialty granules are delivered in bags rather than in bulk. The bags are stacked on pallets for delivery, transfer, and storage and pose no emission problems unless a bag is improperly closed or is broken.

Sand is usually shipped in bulk and handled in the same manner as granules. Because of the generally smaller grain size, the transfer of sand can generate more emissions than the transfer of granules.

Talc is delivered in bags or in bulk. Bulk delivery is more common and is usually by hopper railcars or trucks. Talc may be transferred pneumatically to the storage silo, usually with a positive pressure system. A screw conveyor may be used to transfer the talc from the trucks to storage. The silo is usually enclosed and vented to a fabric filter. Another common approach is to dump the talc from the vehicle hopper onto an underground belt or screw conveyor through a sleeve connecting the vehicle hopper and the conveyor hopper. The material is then transferred to a bucket elevator, raised to the top of the silo, and piped by gravity feed or airslide into a covered silo. Fugitive emission sources are the sleeve interfaces with the hopper and conveyor bin, any open portions of the conveyor system, and material tranfer points. The only other emission source is the exhaust from the talc silo. Bagged material is delivered on pallets, usually by boxcar. The loaded pallets are transferred by fork lift to storage areas. Fugitive emission sources are torn, broken, or inadequately sealed bags.

Mineral stabilizer is delivered in bulk and transferred in the same manner as talc, often by the same conveying equipment. Emission sources are the same as those for talc.

3.2.1.3.4 In-plant transfers and temporary storage. The movements of asphalt and mineral products in a roofing plant are illustrated in the simplified block diagram of Figure 3-7. The techniques used to accomplish these transfers are reviewed in the following paragraphs.

Asphalts are transferred from on point to another in the roofing plant by pipeline; therefore, the only sources of emissions are the end point (flux tanks, in-process tanks, asphalt heater, saturator pan, coater-mixer, coater, etc.) which are discussed elsewhere.

Granules are sometimes tranferred from storage bins to bucket elevator hopper with shovels or a front-end loader. When specialty granules are received and stored in bags, the bags are emptied into the bucket elevator hopper. A much more common technique, however, is to use a belt conveyor to load the bucket elevator. Granules are dumped onto the conveyor belt by

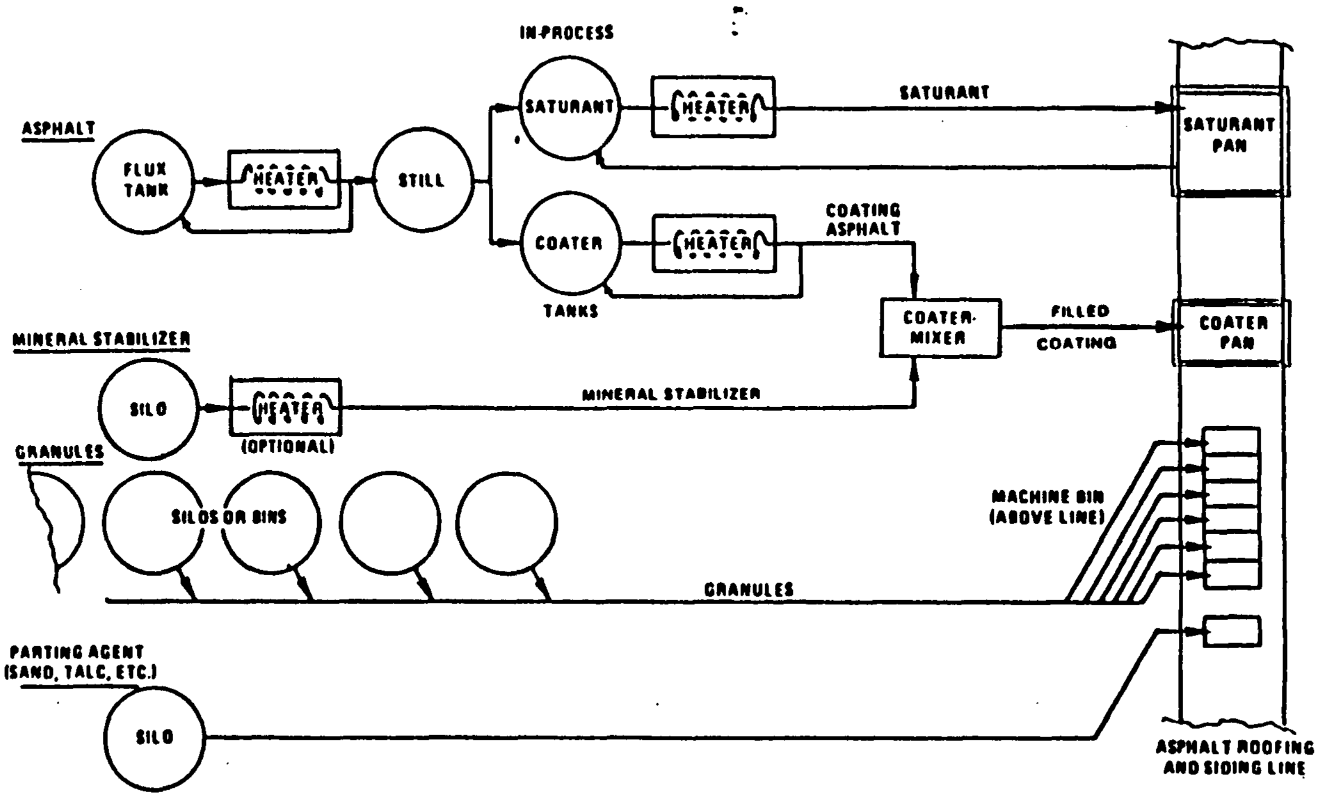


Figure 3-7. Block diagram of in-plant transfers and temporary storage.[10]

gravity, raised by bucket elevator, and fed by gravity through flexible pipes into machine bins. Machine bins, located over the roofing line, provide temporary storage for the particular granule colors needed for the roofing product being manufactured. Some compartments of the machine bins are also used for the parting agent (usually talc). The potential emission sources are the silo/bin unloading point, the conveying system, the bucket elevator hopper, the bucket elevator, and the machine bins. Fugitive emissions from these sources should be minor if the granules are procured oiled (or dyed) and dust-free.

In-plant transfers of sand, sometimes used as a parting agent, are usually conducted in the same manner as granules. The potential emission sources are also the same, but the magnitude of the emissions wil probably be higher as a consequence of the generally smaller grain size of the sand.

Talc, the most commonly used parting agent, may also be transferred within the plant by open belt conveyor and bucket elevator. A more usual approach, however, is the use of gravity, air slides, screw conveyors, and sometimes bucket elevators. Another approach, not yet very common for in-plant transfers, is pneumatic conveying. When talc is received and stored in bags, the bags are emptied into a bucket elevator hopper. Potential emission sources and emissions depend on the transfer system used. When bagged talc is used, both the dumping process and the empty bags are potential emission sources. Other potential emission sources are the belt conveyor, the bucket elevator, and the machine bin. With pneumatic transfer, air slides, and screw conveyors, the only potential sources of emissions are the silo, the machine bin, and (with positive-pressure systems) line leaks.

Mineral stabilizer can be transported using the same techniques as used with talc. However, like talc, mineral stabilizer is more commonly moved by gravity, air slides, screw conveyors, and sometimes bucket elevators. With a gravity feed system, fugitive emission sources are line leaks and any open transfer points. Bucket elevators and their transfer points are sources of fugitive emissions, as are the storage silo and the coater-mixer. These are discussed elsewhere in this chapter. Air slides and screw conveyors are closed systems and are not, of themselves, emission sources.

3.2.1.3.5 Asphalt processing. Asphalt flux is the bottoms from the petroleum refining process. It can consist of the residuums from a single crude of from a blend of many crudes. One difference between the "saturant" and "coating" asphalts is their softening point. Saturants usually have a softening point between 40° and 74°C (104° and 165°F), while coating asphalts soften at about 110°C (230°F). In addition, flexibility at lower temperatures and penetration into the web are important parameters.

Asphalt is blown with air in asphalt blowing stills (see Figure 3-8). A blowing still is a tank fitted near its base with a sparger (air lines in a spider arrangement). The purpose of the sparger is to increase contact between the air and the asphalt. Air is forced through holes in the sparger into a tank of hot [204° to 243°C (400° to 470°F)] asphalt flux. This air rises through the asphalt, participating in an exothermic oxidation reaction. Oxidizing the asphalt has the effect of raising its softening temperature, reducing penetration, and modifying other characteristics. Sometimes a catalyst ($FeCl_3$) is added to assist in this transformation. The time required for air blowing of asphalt depends on a number of factors. These factors include the characteristics of the asphalt flux, the characteristics desired for the finished product, the reaction temperature, the type of still used, the air injection rate, and the efficiency with which the air entering the still is dispersed throughout the asphalt. Blowing times may vary in duration from 30 minutes to 12 hours.

Asphalt flux characteristics depend on the source of the crude and the method used to refine it. The type of flux used will vary from plant to plant but should stay fairly constant at any one plant. The softening point of the products of the blowing process (saturant and coating asphalts) varies from one location to another.

Asphalt blowing is a highly temperature-dependent process, as the rate of oxidation increases rapidly with increases in temperature. Asphalt is preheated to 204° to 243°C (400° to 470°F) before blowing is initiated to assure that the oxidation process will start at an acceptable rate. Conversion does take place at lower temperatures but is much slower. Due to the exothermic nature of the reaction, the asphalt temperature rises as blowing proceeds. This, in turn, further increases the reaction rate. Asphalt temperature is

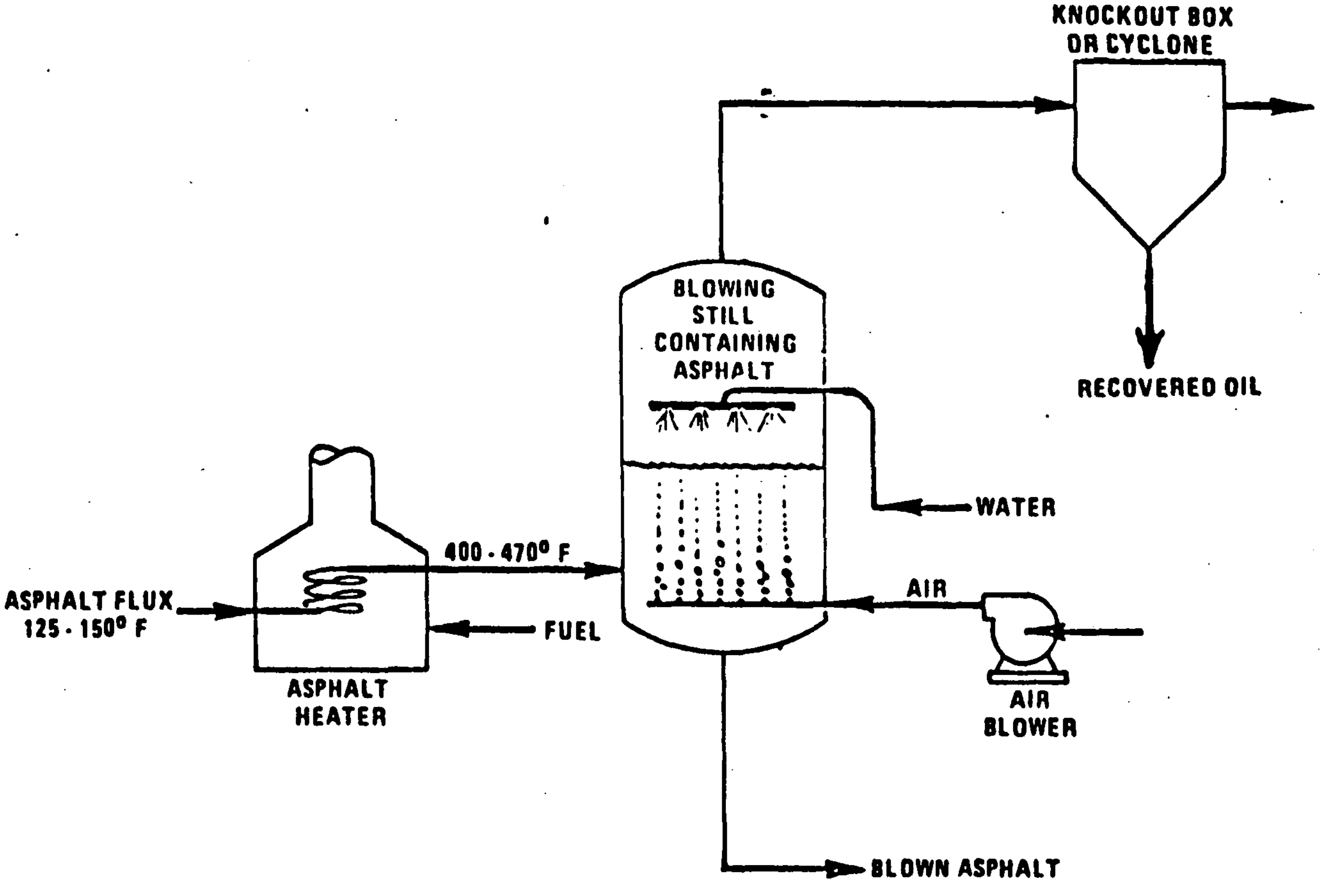


Figure 3-8. Air-blowing of asphalt.[11]

normally kept at about 260°C (500°F) during blowing by spraying water onto the surface of the asphalt, although external cooling may also be used to remove the heat of reaction. The heat of reaction during air blowing is relatively low for some crudes, and auxiliary cooling may not be required. The allowable upper limit to the reaction temperature is dictated by safety considerations, with maximum temperatue of the asphalt usually kept at least 28°C (50°F) below the flash point of the asphalt being blown. The design and location of the sparger in the still governs how much of the asphalt surface area is physically contacted by the injected air, and the vertical height of the still determines the time span of this contact. Vertical stills, because of their greater head (asphalt height) require less air flow for the same amount of asphalt-air contact. Both vertical and horizontal stills are still in use, but where new design is involved, a vertical type is preferred by the industry because of the increased asphalt-air contact and consequent reduction in blowing times. Asphalt losses from vertical stills are also reported to be less than those from horizontal stills. Asphalt blowing can be either a batch process or a continuous operation. All stills at roofing plants are believed to use the batch process, as do most of the asphalt processing plants, but the ratio among refineries is unknown.

The emissions from the blowing still are primarily organic particulate with a fairly high concentration of gaseous hydrocarbon (6,000 to 7,000 ppm) and polycyclic organic matter [112,308 ug/Nm^3 (0.00007 lb/ft^3)]. The blowing still has the highest total emissions of any of the emission sources in the asphalt roofing plant.

3.2.2 Uncontrolled Process Emissions[12] There are a number of emission sources in a typical asphalt roofing manufacturing plant. Emissions result from asphalt handling and storage, asphalt processing, various roofing line operations, and mineral products handling and storage. The potentially significant sources are listed in Table 3-1, which also catalogs some of the parameters which are believed to affect both the magnitude and type of emissions from those activities which involve the processing, storage, or use of asphalt.

There are many variables which could potentially affect emissions from asphalt roofing manufacturing operations. For example, particulate emissions from roofing lines (asphalt fumes for the saturator, wet looper, and coater)

TABLE 3-1. EMISSION SOURCES AND VARIABLES AFFECTING EMISSIONS IN AN ASPHALT ROOFING PLANT

Emission source	Pollutants	Raw material variations influencing emissions	Process parameters influencing emissions
Asphalt storage tank	Gaseous hydrocarbons and particulate	* Type of crude (Middle East, West Coast, midcontinent, Venezuelan) * Characteristics of asphalt (softening point, penetration, viscosity, flash point, etc.)	* Storage temperature * Loading/storage cycle
Asphalt blowing still	Particulate hydrocarbon, gaseous hydrocarbons	* Type of crude * Characteristics of asphalt	* Blowing temperature * Air rate * Design/configuration of still * Type of product (saturant and coating asphalt)
Saturator	Particulate hydrocarbon, gaseous hydrocarbons	* Type of crude * Characteristics of asphalt * Characteristics of web (type, width, weight, moisture content)	* Type of saturator (spray/dip, spray, dip) * Saturant temperature * Line speed
Wet looper	Gaseous hydrocarbons	* Characteristics of asphalt * Characteristics of web	* Line speed
Coater-mixer tank	Particulate hydrocarbon, gaseous hydrocarbons, and inorganic particulates	* Type of filler (limestone, rock dust) * Characteristics of filler (particle shape, density, moisture content) * Characteristics of asphalt	* Temperature of filler * Temperature of coating asphalt * Filler/asphalt ratio

TABLE 3-1. EMISSION SOURCES AND VARIABLES AFFECTING EMISSIONS IN AN ASPHALT ROOFING PLANT (Continued)

Emission source	Pollutants	Raw material variations influencing emissions	Process parameters influencing emissions
Coater	Particulate hydrocarbon, gaseous hydrocarbons, and inorganic particulates	* Characteristics of asphalt * Type of crude * Characteristics of web * Type and proportion of filler used	* Line speed * Amount of coating applied
Surface application	Inorganic particulates	* Type of backing agent (sand, talc, mica) * Characteristics of backing agent	* Line speed * Type of product
Sealant strip application	Gaseous hydrocarbons	* Characteristics of asphalt	* Line speed * Type of product
Materials handling	Inorganic particulates	* Type of backing agent, filler, and granules * Particle size range	* Type of conveyor (belt, pneumatic screw, manual)
Filler dryer	Inorganic particulate combustion gases	* Type of filler * Moisture content * Particle size range of filler	* Type of dryer * Firing method
Modified bitumen mixing tank	Particulate hydrocarbons, gaseous hydrocarbons, and inorganic particulates	* Type of filler * Characteristics of filler * Characteristics of asphalt * Type of polymers * Characteristics of polymers	* Temperature of asphalt * Temperature of mixture * Filler/asphalt/polymer ratio
Modified bitumen impregnation vat	Particulate hydrocabons, gaseous hydrocarbons, and inorganic particulates	* Characteristics of modified bitumen mixture * Characteristics of web	* Line speed * Amount of mixture applied * Temperature of mixture

may increase on a kilogram-per-megagram-shingle basis, with increases in line speed. No test data are available to confirm or disprove this statement. Also, a number of industry representatives are of the opinion that spray or spray/dip saturators create more fumes than to dip saturators, other factors being equal. The test data collected during the original NSPS development process suggests a similar conclusion since the one spray/dip saturator tested generated 5 to 10 times as much particulate emission on a kilogram-per-hour basis as the dip saturators tested. It is also hypothesized that:

1. uncontrolled emissions are higher for asphalts derived from the more volatile West Coast or Middle East crudes than from the midcontinent crudes;
2. vertical stills emit fewer fumes than horizontal units;
3. uncontrolled emissions from roofing lines are lower when saturants and coatings are used which have higher than normal softening points; and
4. uncontrolled emissions of asphalt particulate increase with increases in the moisture content of the organic felt.

The effect of these variables on uncontrolled emission rates has not been isolated and quantified. During the original NSPS development program, however, plants were tested in different parts of the country and with different types of saturators, so the range of data collected should encompass the effects of many of these variables. A summary of the test data for uncontrolled emissions collected at that time is presented in Table 3-2. The test method used on sources of asphalt fumes is EPA Method 5A: Determination of Particulate Emissions From the Asphalt Processing and Asphalt Roofing Industry.

3.2.2.1 Emissions from Asphalt Handling and Storage. During the original NSPS development program, the uncontrolled emissions from one asphalt surge tank and five 114-m^3 (30,000-gal) asphalt storage tanks were measured at one roofing plant. Hot asphalt was being unloaded from trucks, recirculated to the saturator, and pumped to the coatermixer while the tests were conducted. The range of uncontrolled emissions was from 0.64 kg/h (1.4 lb/h) to 1.63 kg/h (3.6 lb/h). The average emission rate for the three tests was 1.0 kg/h (2.2 lb/h).

TABLE 3-2. UNCONTROLLED EMISSIONS FROM ASPHALT ROOFING PLANTS FROM TEST DATA OBTAINED DURING ORIGINAL NSPS DEVELOPMENT[13]

		Production rate[a]		Uncontrolled emissions[a]					
Plant	Emission Source	Mg/yr	tons/yr	kg/h	lb/h	kg/Mg	lb/ton	Mg/yr	tons/yr
A	Saturator, dip coater	112,590	124,120	6.62	14.59	0.235	0.47	26.50	29.20
B	Saturator, dip coater	147,680	162,800	12.50	27.50	0.340	0.68	49.90	55.00
	Storage tanks[b]			1.00	2.20	0.080	0.16	3.99	4.40
C	Saturator, spray-dip coater, and storage tanks	76,300	84,120	29.93	66.00	1.570	3.14	119.70	132.00
D	Saturator, dip	173,070	190,800	6.93	15.27	0.160	0.32	27.76	30.60
E	Blowing still[c]								
	Saturant	13,430	14,800	80.00	176.4	3.440	6.89	46.24	50.98
	Coating	11,700	12,900	98.60	217.4	12.690	25.38	148.50	163.70

[a] Yearly production and emissions are based on the roofing line operating and producing shingle 4,000 hours per year and the blowing still operating 2,000 hours per year. Saturant and coating asphalts are blown 573 and 1,427 hours per year respectively.

[b] Five 114 m^3 (30,000 gal) storage tanks were tested. Emission rate in kg/Mg (lb/ton) based on usage of 12.5 Mg/h (13.75 tons/h) of asphalt from storage tanks.

[c] Tested still has a working capacity of 36.34 m^3 (9,600 gal) compared to 75.71 m^3 (20,000 gal) and 94.64 m^3 (25,000 gal) for model plants.

3.2.2.2 Emissions from Blowing Stills. One blowing still installation was tested during the original NSPS development program. The uncontrolled emission rate was measured during three saturant asphalt blows and three coating asphalt blows. The range of uncontrolled emissions during the saturant blows was from 57.61 kg/h (127 lb/h) to 102.97 kg/h (227 lb/h). The average emission rate for the three saturant blow tests was 80 kg/h (176 lb/h). The rate of uncontrolled emissions from the coating blows varied from 95.71 kg/h (211 lb/h) to 103.87 kg/h (229 lb/h). The average for the three coating blows was 98.6 kg/h (217 lb/h). The average uncontrolled emission rate for all six runs was 89.4 kg/h (197 lb/h).

3.2.2.3 Emissions from Roofing Line Operations. During development of the original NSPS, emission tests were conducted at four asphalt roofing plants where emissions from a varied grouping of sources were measured.

At Plant A the emissions from the dip saturator, wet looper, and coater were measured. The uncontrolled emissions varied from 4.99 kg/h (11 lb/h) to 7.98 kg/h (17.6 lb/h), and the average of the four tests was 6.62 kg/h (14.6 lb/h).

At Plant B the emissions from the dip saturator, wet looper, and coater were measured. The uncontrolled emissions ranged from 8.89 kg/h (19.6 lb/h) to 15.15 kg/h (33.4 lb/h), with an average emission rate of 12.5 kg/h (27.5 lb/h).

There were three tests conducted to determine the emissions from a spray-dip saturator, wet looper, coater, and eight asphalt storage tanks at Plant C. The data from one of the tests cannot be used because of an accidential bumping of the stack wall with the sampling probe during the test. The uncontrolled emission rate for the two tests were 31.52 kg/h (69.5 lb/h) and 28.39 kg/h (62.6 lb/h).

The uncontrolled emissions from a dip saturator and wet looper were measured at Plant D. There were three tests, and the emissions ranged form 4.99 kg/h (11 lb/h) to 10.16 kg/h (22.4 lb/h). The average for the three tests was 6.93 kg/h (15.3 lb/h).

No uncontrolled emissions data has been obtained for a coater only (which is the situation during the production of fiberglass products).

3.2.2.4 Emissions from Mineral Handling and Storage. Particulates may be emitted from any of the mineral handling and transfer operations, but most of the particulate emissions usually occur at transfer points and use points. No tests were conducted during this program to determine the emissions from mineral transfer and storage operations (screw conveyors, belt conveyors, air slides, bucket elevators, pneumatic conveyors, and silos). Uncontrolled emissions from the conveying, screening, and handling of crushed stone have been estimated to be 1 kg/Mg (2 lb/ton) of inorganic particulate.

3.2.2.5 Emissions from Modified Bitumen Production. The emissions from modified bitumen mix tanks and impregnation vats may include particulate hydrocarbons, gaseous hydrocarbons, and inorganic particulate. The various individual mixtures of asphalt/polymers/fillers will each produce emissions of slightly different characteristics.

There has been no uncontrolled emissions data obtained for modified bitumen mixing tanks using EPA Method 5A. Uncontrolled particulate emissions data was obtained, however, for two impregnation vats during the production of the polypropylene type of modified bitumen roofing at one plant. The uncontrolled emissions from Vat 1 ranged from 0.13 kg/h (0.29 lb/h) to 0.21 kg/h (0.46 lb/h), and the average of three tests was 0.17 kg/h (0.37 lb/h). For Vat 2, the uncontrolled emissions varied from 0.06 kg/h (0.14 lb/h) to 0.10 kg/h (0.21 lb/h), with an average emission rate of 0.08 kg/h (0.18 lb/h).[14]

3.3 INDUSTRY SIZE

The Asphalt Roofing Manufactures Association (ARMA) furnished a list of 88 members company plants as of May 1, 1987, which produce shingles or roll goods as their primary product. This list is shown in Table 3-3. These plants are owned by 27 companies, and located in 27 States. Thirty-five percent of the plants are concentrated in three States; California, Texas, and Ohio, and approximately 43 percent of these plants are owned by three companies.[15] The companies which comprise the asphalt roofing industry vary greatly in size and diversity. A single manufacturer may have only one plant or more than ten. Each facility may produce only one specific type of roofing material or several types. One line can often produce more than one product, and a plant may have one or more roofing lines. The larger firms often produce their own webbing materials, or process their own asphalt.

Production by members of ARMA is estimated to be 90 percent of the asphalt roofing market.[16] The 1986 industry shipments for reporting ARMA members are presented in Table 3-4.

Saturant and coating asphalts are normally classified as intermediate products because they are used in the manufacture of roofing line products. Saturant and coating asphalts are, however, end products for some companies since they are not always produced at roofing plants. Much of the saturant and coating asphalt used by asphalt roofing plants is prepared at refineries or by asphalt processors. Fifty-two petroleum firms with 76 refineries reported a capacity to produce asphalt as of January 1, 1986.[17] There are several small companies which buy asphalt flux to produce saturants and coatings for the asphalt roofing industry.

TABLE 3-3. ASPHALT ROOFING MANUFACTURERS ASSOCIATION MEMBER COMPANY PLANTS[17]

COMPANY	ROOFING PLANTS	MODIFIED BITUMEN PLANTS
American Roofing Corporation Chicago, IL		Chicago, IL
Betec Incorporated Morrilton, AK		Morrilton, AK
Bird Incorporated East Walpole, MA	Norwood, MA	
Celotex Corporation Tampa, FL	Camden, AR Fremont, CA Fairfield, AL Goldsboro, NC Houston, TX Lockland, Cinn., OH Perth Amboy, NJ San Antonio, TX Los Angeles, CA Memphis, TN	Lockland, OH
Consolidated Fiberglass Products Bakersfield, CA	Bakersfield, CA	
Dibiten, U.S.A. South Gate, CA		South Gate, CA
Elk Corporation of America Dallas, TX	Ennis, TX Tuscaloosa, AL	
Evanite/Permaglass, Incorporated Corvallis, OR	Corvallis, OR	
GAF Corporation Wayne, NJ	Baltimore, MD Dallas, TX Erie, PA Fontana, CA Millis, MA Minneapolis, MN Mobile, AL Mount Vernon, IN Savannah, GA Tampa, FL	Mount Vernon, IN

TABLE 3-3. ASPHALT ROOFING MANUFACTURERS ASSOCIATION MEMBER COMPANY PLANTS[17] (Continued)

COMPANY	ROOFING PLANTS	MODIFIED BITUMEN PLANTS
The Garland Company Cleveland, OH		Cleveland, OH
Georgia-Pacific Corporation Atlanta, GA	Ardmore, OK Daingerfield, TX Franklin, OH Hampton, GA Quakertown, PA Denver, CO	
Globe Industries, Incorporated Chicago, IL	Whiting, IN St. Paul, MN	
IKO Industries, Ltd. Toronto, Ontario, Canada	Wilmington, DE Chicago, IL Franklin, OH	
Koppers Company Pittsburgh, PA	Chicago, IL Fontana, CA Houston, TX Wickliffe, OH Woodward, AL Youngstown, OH	
Leatherback Industries Hollister, CA	Albuquerque, NM Hollister, CA Auburn, WA	
Lunday - Thagard South Gate, CA	South Gate, CA	
Manville Corporation Denver, CO	Fort Worth, TX Manville, NJ Pittsburg, CA Savannah, GA Waukegan, IL	Waukegan, IL
Nord Bitumi U.S., Inc. Springfield, NJ		Plattsburgh, NY Macon, GA

TABLE 3-3. ASPHALT ROOFING MANUFACTURERS ASSOCIATION MEMBER COMPANY PLANTS[17] (Continued)

COMPANY	ROOFING PLANTS	MODIFIED BITUMEN PLANTS
Owens-Corning Fiberglas Corp. Toledo, OH	Atlanta, GA Brookville, IN Compton, CA Denver, CO Houston, TX Irving, TX Jacksonville, FL Jessup, MD Kearny, NJ Medina, OH Memphis, TN Minneapolis, MN Morehead City, NC Oklahoma City, OK Portland, OR Santa Clara, CA Summit, IL	Kansas City, MO Morehead City, NC
Siplast Incorporated Arkadelphia, AK		Arkadelphia, AK
TAMKO Asphalt Products, Inc. Joplin, MO	Frederick, MD Joplin, MO Phillipsburg, KS Tuscaloosa, AL Dallas, TX	Joplin, MO
Tarmac Roofing Systems, Inc. Wilmington, DE		Chester, PA
Teltex North Branford, CT		North Branford, CT
Tremco, Incorporated Cleveland, OH		Cleveland, OH
U.S. Intec, Incorporated Port Arthur, TX		Port Arthur, TX North Branch, NJ Stockton, CA
W.R. Grace & Company Cambridge, MA		Cambridge, MA

TABLE 3-4. INDUSTRY SHIPMENTS FOR REPORTING ARMA MEMBERS IN 1986[18]

PRODUCT	SQUARES[a]
Strip Shingles	
- Standard Organic (235-240 lbs/square)	11,360,110
- Other Organic	639,030
- Standard Inorganic (215-235 lbs/square)	64,734,952
- Other Inorganic	3,919,087
- Laminated, Multi-Layered Organic or Inorganic	7,393,002
Individual Shingles	
- Organic or Inorganic	1,338,476
Roll Roofing	
- Organic Smooth Surfaced	4,831,187
- Inorganic Smooth Surfaced	8,589,401
- Organic Mineral Surfaced	8,618,442
- Inorganic Mineral Surfaced	8,351,694
Ply Felts	
- Organic	5,276,469
- Inorganic	42,423,488
	TONS
Saturated Felt	
- Organic	390,066

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[a] One square = 100 feet of covered roof

3.4 REFERENCES

1. U.S. Environmental Protection Agency. Asphalt Roofing Manufacturing Industry - Background Information for Proposed Standards. EPA-450/3-80-021a. June 1980. p. 3-8 to 3-18.

2. Reference 1, p. 3-9.

3. Reference 1, p. 3-10.

4. Reference 1, 3-14.

5. Reference 1, 3-16.

6. Memo from Michelitsch, D.M., EPA: ISB, to Durkee, K.R., EPA: ISB. May 5, 1987. Report on March 1987, trip to U.S. Intec, Inc., North Branch, New Jersey. 6 p.

7. Memo from Michelitsch, D.M., EPA: ISB, to Durkee, K.R., EPA: ISB. June 3, 1987. Report on March 1987, trip to Nord Bitumi U.S., Inc., Plattsburgh, New York. 3 p.

8. Memo from Michelitsch, D.M., EPA: ISB, to Durkee, K.R., EPA: ISB. March 12, 1987. Report on January 1987 meeting with representatives of the Asphalt Roofing Manufacturers Association (ARMA). p. 2.

9. Reference 1, p. 3-18 to 3-22.

10. Reference 1, p. 3-27.

11. Reference 1, p. 3-31.

12. Reference 1, p. 3-32 to 3-39.

13. Reference 1, p. 3-37.

14. Reference 6: Attached test report of July 8-9, 1986, from the Port Arthur, Texas facility.

15. Materials from Brennan, J., Asphalt Roofing Manufacturers Association, to Michelitsch, D.M., EPA. July 10, 1987. Member company plants as of May 1, 1987.

16. Telecon. Snyder, Richard D., Asphalt Roofing Manufacturers Association, with Michelitsch, Deborah M., EPA. July 7, 1987. Miscellaneous information on asphalt roofing industry.

17. Cantrell, A. Annual Refining Survey. The Oil and Gas Journal. p. 100 - 115. March 24, 1986.

18. Reference 15.

19. Reference 15: Twelve Month Cumulative Summary of Asphalt Roofing Industy Shipments for Reporting Companies as of April 1987.

4.0 EMISSION CONTROL TECHNOLOGY

The control systems used in the asphalt processing and asphalt roofing manufacturing industry include various types of hoods, total enclosure capture systems, and add-on control devices. Emission sources and add-on control devices are summarized in Table 4-1.

4.1 CAPTURE SYSTEMS[1]

Capture of emissions from asphalt blowing stills, asphalt storage tanks, asphalt truck unloading, the coater-mixer, modified bitumen mixing tanks, and from mineral* and granule unloading, storage and transfer systems can be accomplished by the use of closed systems. Uncontrolled emissions from the mineral surfacing and granule application areas can be captured by hoods or by total enclosure of the application area.

Emissions from the saturator, wet looper, and coater or modified bitumen impregnation vats are usually collected by a single enclosure, by a canopy type hood, or by an enclosure and hood combination (saturator and wet looper enclosed and coater hooded). A typical enclosure for a saturator, wet looper, and coater is shown in Figure 4-1; the doors shown allow the operators access as required for maintenance and repair. This particular system is designed with two-stage fans to provide additional exhaust ventilation during periods when the doors are open. The ventilation requirements to obtain complete pickup will vary depending on the extent to which openings in the enclosures are minimized and on safety considerations.

Safety considerations dictate that the concentration of combustible pollutants at the fume source and in the capture system be kept below the lower flammability limit. The resulting fume streams, since they will not support combustion unaided, are classified as "dilute."

4.2 CONTROL DEVICES FOR ORGANIC AND INORGANIC PARTICULATES[2]

Several types of control devices are used in this industry for control of pollutants. The devices include high velocity air filters (HVAF), mist eliminators (ME), afterburners, electrostatic precipitators (ESP), and fabric filters. These devices are discussed in detail in the following paragraphs.

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*This classification includes mineral stabilizer, talc, and sand.

TABLE 4-1. ASPHALT ROOFING PLANT EMISSION SOURCES AND ADD-ON CONTROL DEVICES[3]

Emission sources	Control devices
A. Saturator, wet looper (hot looper), and coater[a]	Mist eliminator High velocity air filter Electrostatic precipitator
B. Coater-mixer[b]	High velocity air filter
C. Asphalt blowing still	Afterburner
D. Asphalt storage tanks[c]	Mist eliminator
E. Mineral surfacing and granule application	Baghouse
F. Granule and mineral delivery, storage, and transfer	Baghouse(s)
G. Modified bitumen mixing tanks	Mist eliminator High velocity air filter Electrostatic precipitator Afterburner
H. Modified bitumen impregnation vat	Mist eliminator High velocity air filter Electrostatic precipitator

[a] These sources usually share a common enclosure, and emissions are ducted to a common control device.

[b] Emissions from the coater-mixer are controlled, at some plants, by routing fumes to the control device used for sources list in A, above.

[c] Some plants control emissions from storage tanks with the same device used for processes listed in A and then use a mist eliminator during periods when the roofing line is not operating (e.g., weekends). Asphalt delivery can be accomplished via a closed system which vents emissions to the same control device as that used for the tanks.

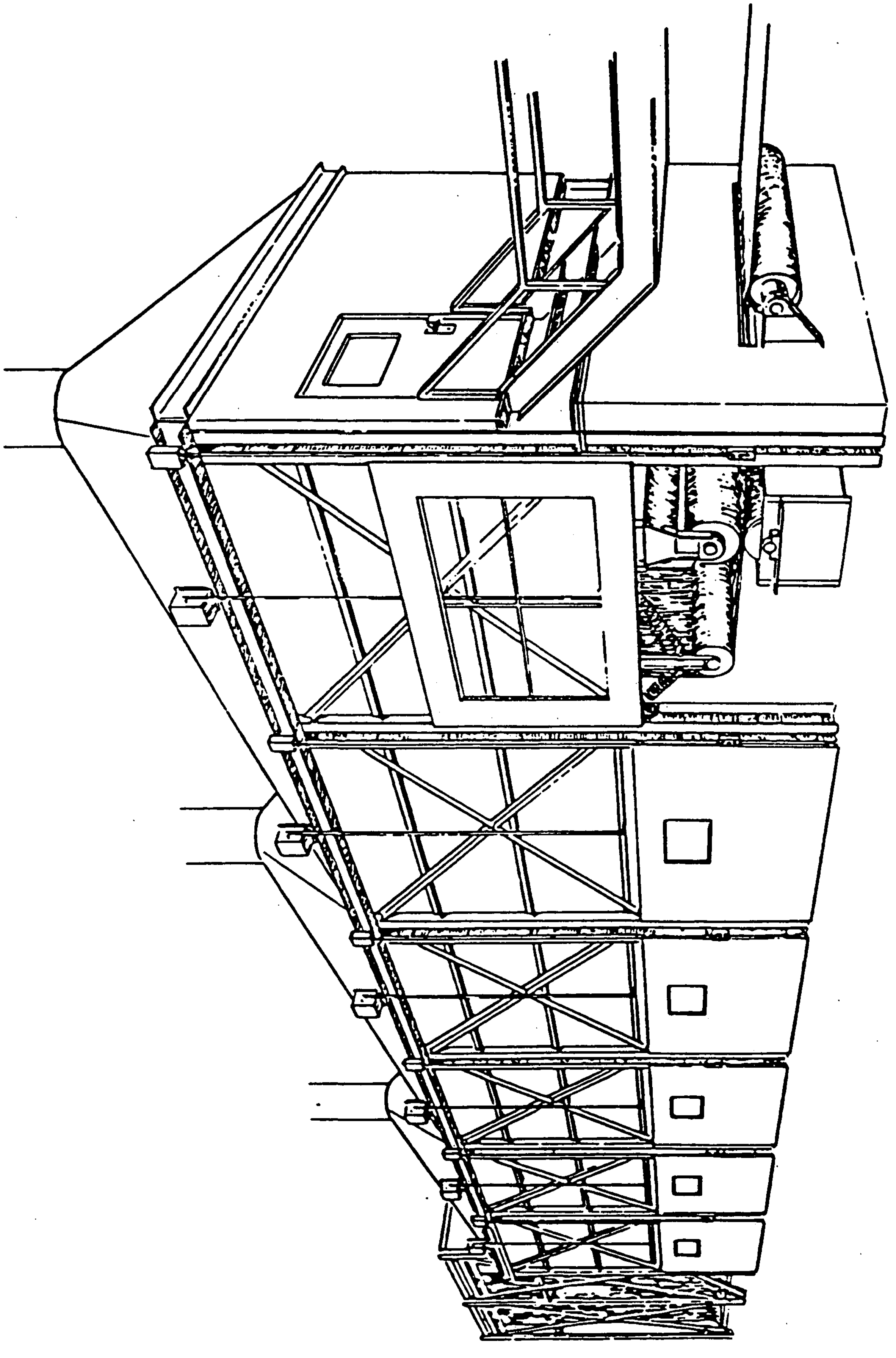

Figure 4-1. Total enclosure of saturator, wet looper, and coater.[4]

4.2.1 High Velocity Air Filter (HVAF)

HVAF's can be used in asphalt roofing plants to collect particulate hydrocarbons emitted from the saturator, wet looper, and coater, modified bitumen mix tanks and impregnation vats, and are sometimes used to collect particulate hydrocarbons emitted from the coater-mixer and asphalt storage tanks.[5,6] A typical rotary drum high velocity air filter installation is shown in Figure 4-2. Its basic components are a cooling section, a motor-driven fan, a rotating drum filter section, and a mist eliminator.

HVAF units are filtration devices and do not remove gas phase organic compounds contained in the exhausts from saturators, wet loopers, coaters, modified bitumen mix tanks and impregnation vats, and asphalt storage tanks. Thus, for effective capture of hydrocarbon emissions, the gases entering the HVAF unit must be cooled to about 32° to 49°C (90° to 120°F). The cooling may be accomplished by either dilution air, water sprays, or a shell and tube heat exchanger.

Dilution air cooling requires a larger fan, fan motor, and a larger control device to handle the increased air volume. Cooling by direct contact water spray is simple and requires less energy and smaller equipment. It does produce an oil-water mixture which must be settled so that the oil can be used for fuel or recycled to an oil refinery, and the water can be recycled to the spray cooler. With a shell and tube heat exchanger, the fan, fan motor, and particle capture device would be smaller than that required for air cooling, and the oil-water separator would not be required. Condensed oil could be drained from the cooler and used directly for fuel or for recycle. However, the shell side of the exchanger would require solvent cleaning several times a year to avoid fouling. The waste solvent would create a waste disposal problem. A fan would be required to overcome the additional pressure drop.

Precooling and condensation minimizes the amount of organic vapors which would otherwise pass through the filter and condense in the atmosphere to produce a visible plume. The quantity of gaseous organic emissions and the extent of precooling needed to prevent a visible plume are somewhat dependent upon the particular crude and the degree of refining of the crude from which the asphalt is produced.[7]

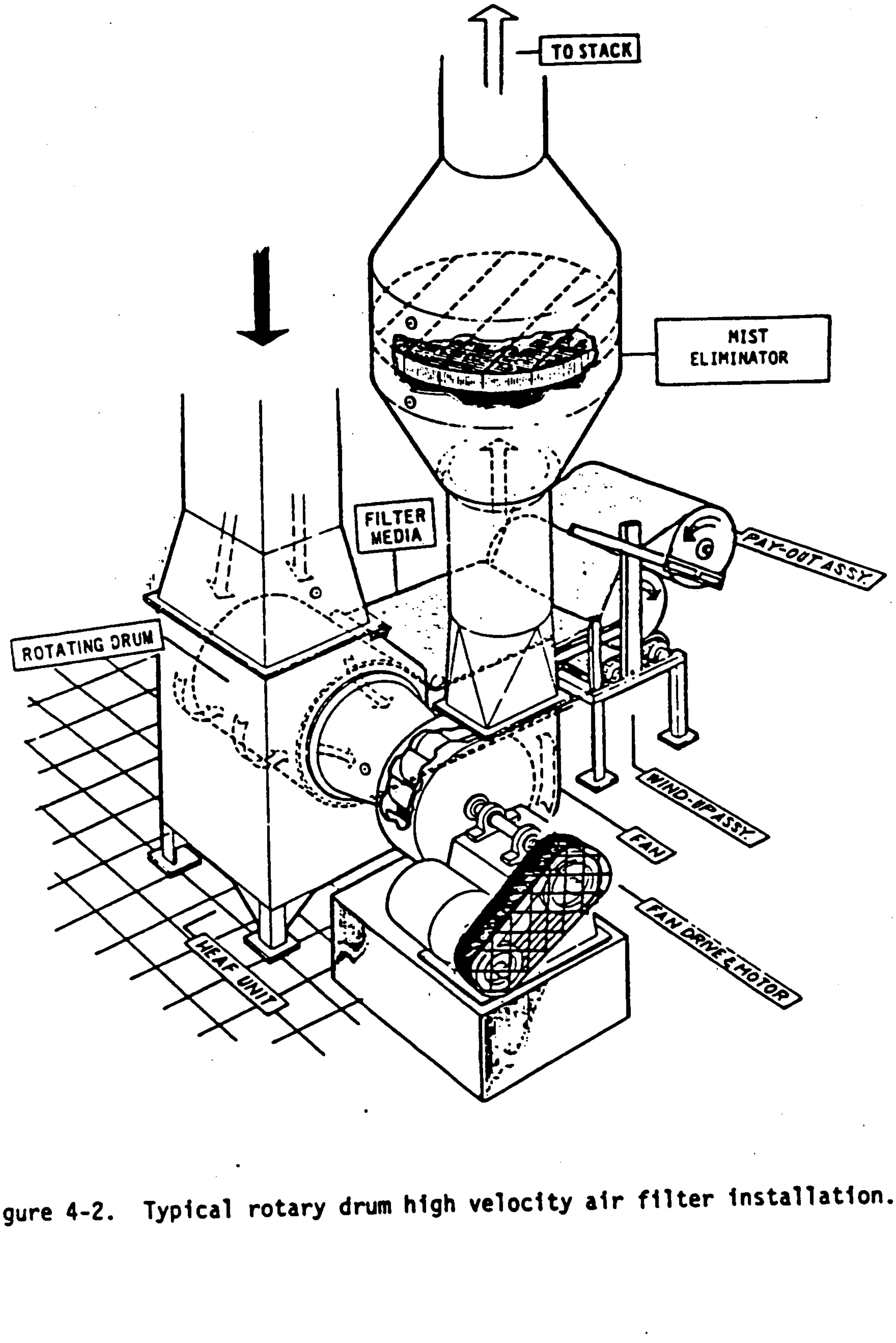

Figure 4-2. Typical rotary drum high velocity air filter installation.[8]

As the exhaust gases pass through the HVAF filter media, particulates impact on the glass fibers and are separated from the gas stream. The filter media is supported by a screen and a perforated drum retainer, as shown in Figure 4-2. The filter media is a 2.54-cm (1-in.) thick fiber glass mat having a density of 0.20 kg/m^2 (0.66 oz/ft^2). The fibers are random and have a diameter of about 4 um.[7] High filter face velocities are necessary to attain high collection efficiency, as shown in Figure 4-3. Experience with systems operating at asphalt roofing plants has shown that the system should be designed so that the gases pass through the filter media at a face velocity of between 7.62 and 8.64 m/s (1,500 and 1,700 ft/min), which produces a pressure drop of about 6,966 Pa (28 in. of water). The fan horsepower required for a system capable of handling 18.9 m^3/s (40,000 acfm) is usually in the range of 223,700 to 261,000 W (300 to 350 hp).[7]

The inorganic particulates and the more viscous organic compounds collect on the filter mat and eventually begin to plug it. The micron and submicron size liquid particles attach themselves to the fibers of the filter media and migrate to the discharge side of the mat where they again enter the high velocity air stream as larger, liquid oil droplets. Periodically, the filter media is advanced to expose a small surface of new material to the exhaust flow. Automatic advance of the filter media may be accomplished at either a predetermined time interval or at a predetermined pressure drop across the filter media. With the time-operated advance, if new material is advanced while the process is shut down, a large filter area may be "uncaked" and the pressure drop will be low, resulting in decreased collection efficiency. Some HVAF systems incorporate a pressure-actuated advance system which operates by sensing pressure at the mat and advancing the filter at a given rate until a preset lower pressure is reached at the mat.

Large oil droplets entering the high velocity air stream from the filter of the HVAF unit pass through a fan and are collected on a mesh-type mist eliminator (see Figure 4-2). The filter media is a 15.2-cm (6-in.) thick mat (packing) of stainless steel fibers retained between stainless steel grids. The face velocity of the gas stream is 1.8 to 2.4 m/s (6 to 8 ft/s) and the pressure drop is $\leq$1.27 cm (0.5 in.). When the pressure drop increases to 2.54 cm (1.0 in.), cleaning of the mist eliminator is necessary. Cleaning of

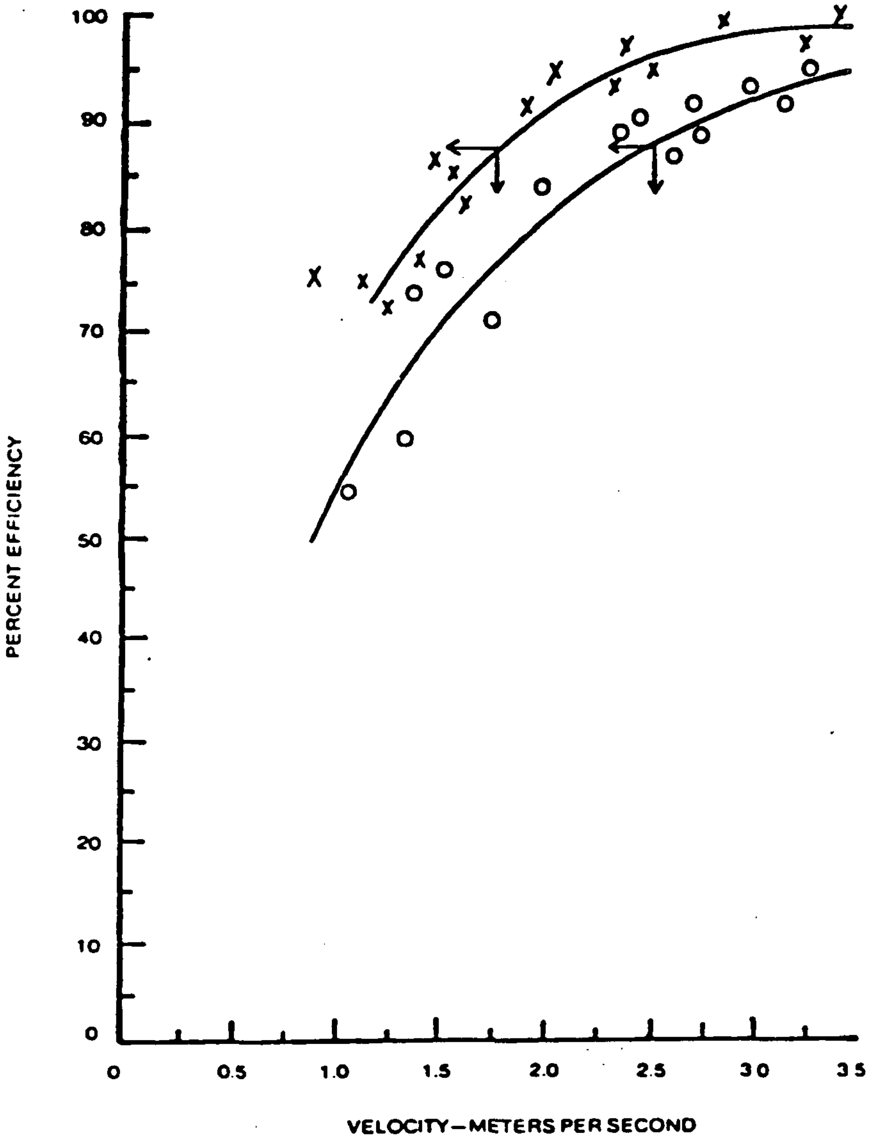

Figure 4-3. HVAF filter media filtration efficiency as a function of filter face velocity for different filter media.[9]

the mist eliminator is usually performed annually although at a few installations it may be done every 6 months.[10]

A smaller version of the high velocity air filter is shown in Figure 4-4. This type of unit is typically installed for application where the emissions are intermittent, where the gas flows are low [0-2.36 m^3/s (0-5000 acfm)], and where capital costs might be minimized. Mini-HVAF's are sometimes used to control emissions from the coater-mixer at asphalt roofing plants. The basic operation and characteristics of the mini-HVAF are essentially the same as those detailed above for the HVAF unit, except that the filter media is sandwiched between two quick-release flanges, and periodically it is changed manually. The need for regular manual filter changes is a disadvantage of the unit.

Among the advantages of HVAF units in the asphalt roofing industry are: ease of operation, low maintenance, and no fuel costs. The major disadvantages are: a lack of control of gaseous emissions, the large pressure drops requiring higher energy consumption, and the disposal and handling problems associated with the used mats. The saturated mats can become a secondary emission source unless proper care is taken to minimize outgassing. Outgassing can occur while the saturated mat is being accumulated on the HVAF takeup reel (windup assembly), during temporary storage, during transport for disposal, or during disposal.

4.2.2 Mist Eliminators

Mist eliminators are used in numerous industrial applications to remove both liquid mists and soluble solids from gas streams. Mist eliminators cannot be subjected to high concentrations of inorganic particulate matter or very large organic particles because the collection media soon becomes plugged. Thus, where high concentrations of inorganic particulate or very large organic particles are present in the exhaust stream, a cleanable or replaceable type prefilter is needed to remove the bulk of the particulates.[11, 12] In asphalt roofing plants, mist eliminators can be used to control emissions from asphalt storage tanks, saturators, wet loopers, and coaters, and modified bitumen mixing tanks and impregnation vats.[13]

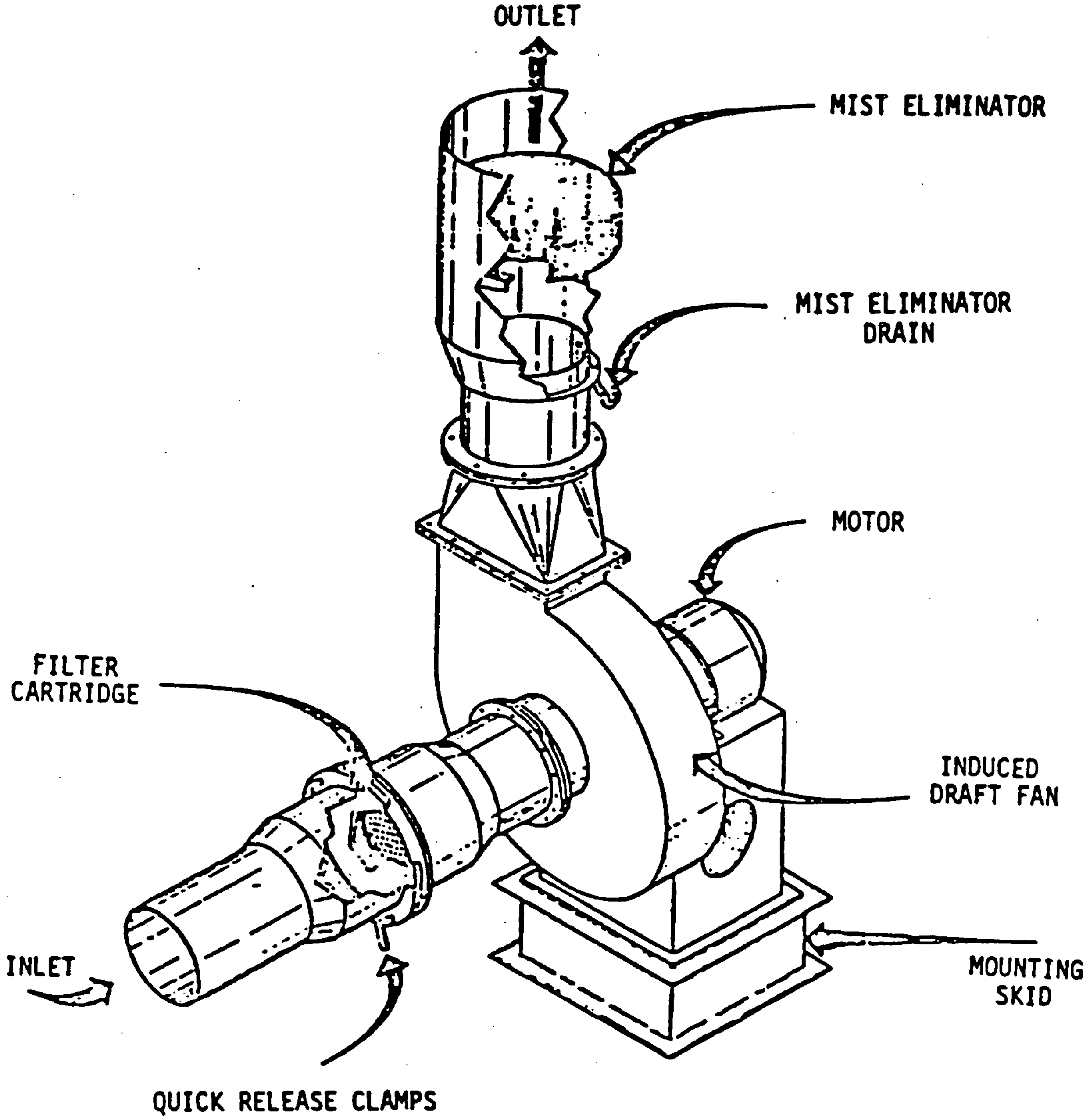

Figure 4-4. Typical mini-HVAF.[14]

A typical mist eliminator element consists of a packed fiber bed retained between two screens as shown in Figure 4-5. The screens can be concentric cylindrical screens or parallel flat screens. Chemically resistant glass fibers, synthetic fibers, stainless steel fibers, and other fiber materials can be used as packing, depending upon the composition of the effluent stream. Gases containing mist particles flow into the fiber bed where the mist particles are collected on the fibers by inertial impaction, direct interception, and Brownian movement. The collected liquid particles coalesce into liquid films which are moved through the fiber bed by the drag of the gases. The collected liquid drains by gravity off the downstream face of the fiber bed to a separate storage vessel (as shown in Figure 4-6).

The oil collected by a mist eliminator can be disposed of in a number of ways. Some plants use it as fuel for their boilers while others recycle the oil back to the saturator or the storage tanks.

The effectiveness of mist eliminators depends on particle size, particulate loading, liquid viscosity, fiber dimensions, bed density, and gas velocity through the bed. Particle size is one of the most important considerations involved in the design and construction of mist eliminators. A wide range of particle sizes may be handled. Larger particles may be collected by a cyclone, mesh pad, or prefilter. The mist eliminator can then be designed to remove the smaller particles with high efficiency. A wide range of pollutants, particulate loadings, and gas volumes can be handled with high efficiency by mist eliminators. This device can handle a wide range of viscosities (up to 5,000 cp) as long as the collected particles can be made to drain from the bed.[15]

The typical mist eliminator unit for a saturator and wet looper is shown in Figure 4-7. This unit will have a set of prefilters, followed by a precooling section, and then a tube sheet of between 10 and 20 cylindrical mist eliminator elements.[16, 17, 18]

Among the advantages of the mist eliminator are a moderate pressure drop (less than half that of the HVAF), a relatively infrequent cleaning or repacking cycle, and no fuel costs. The disadvantages include an inability to control gases and odors and the secondary pollution impact of the repacking, cleaning, or disposal processes for prefilters and mist eliminator elements.

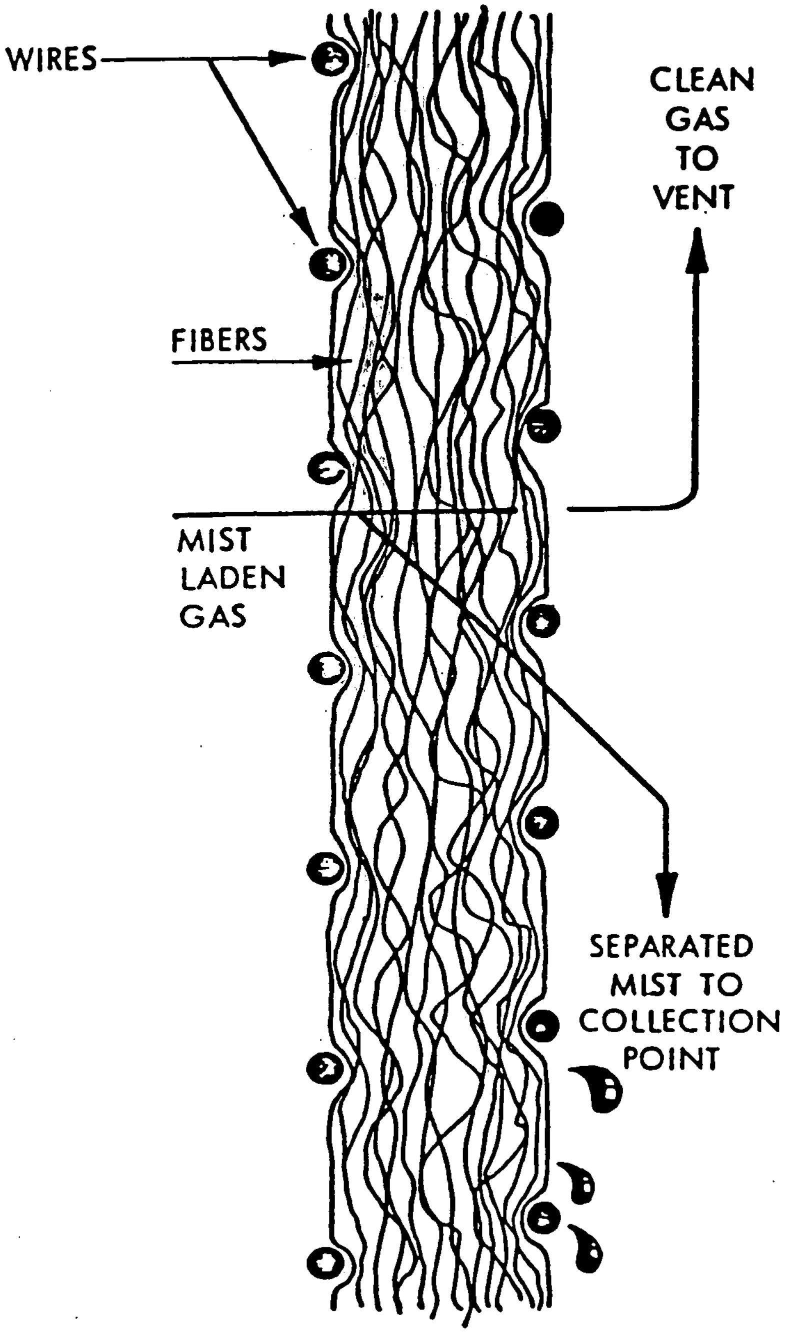

Figure 4-5. Schematic of retaining screens and fiber packing of a mist eliminator.[19]

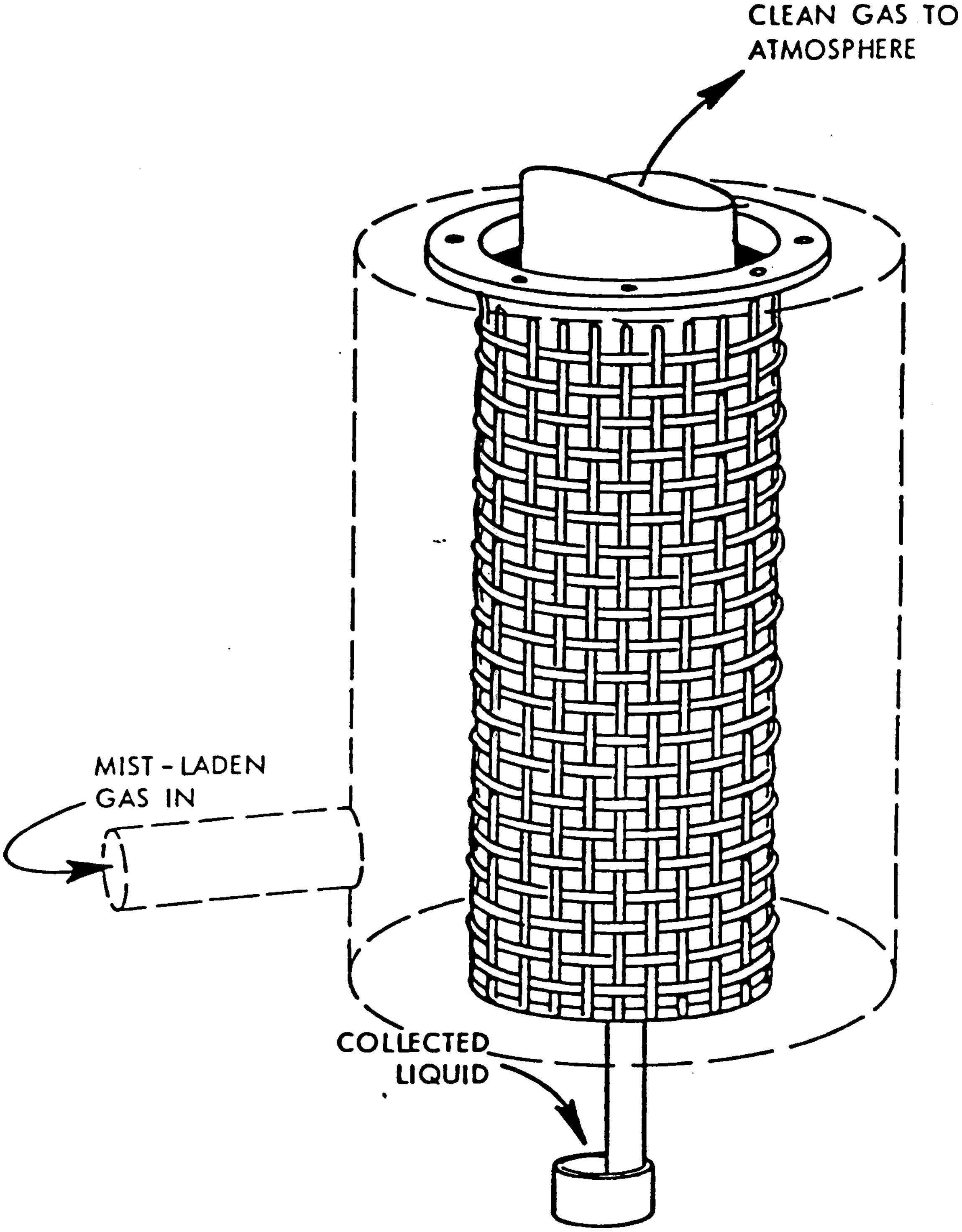

Figure 4-6. Typical cylindrical mist eliminator element.[20]

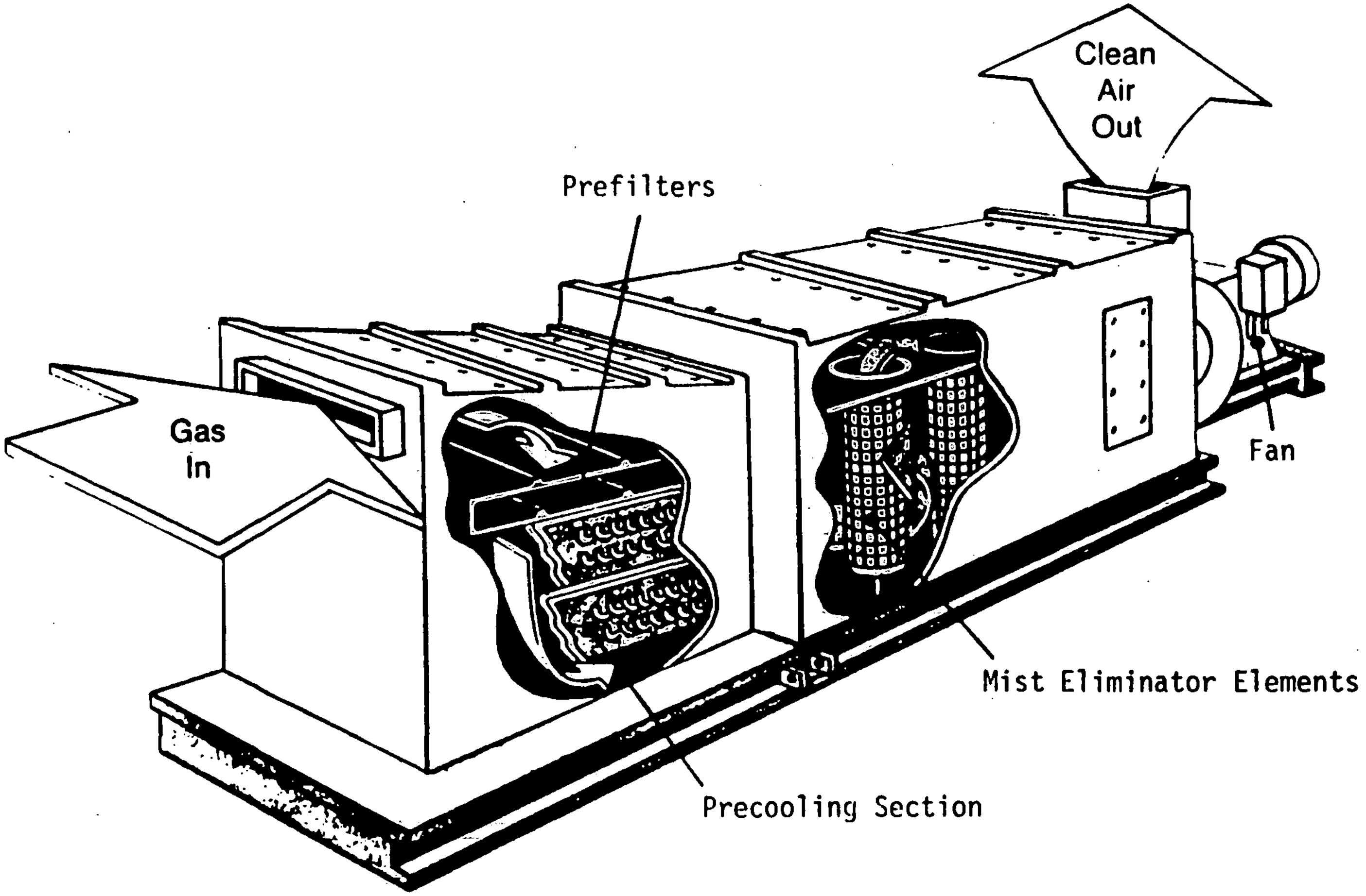

Figure 4-7. Typical mist eliminator unit for a saturator and wet looper.[21]

4.2.3 Afterburners

An afterburner, as discussed in this document, means any exhaust gas incinerator used to control emissions of particulate matter. Afterburners are typically used to control combustible pollutants present in concentrations too dilute to support combustion unaided. Afterburners can be used in asphalt roofing manufacturing plants to control emissions of gaseous hydrocarbons and organic particulates from the asphalt blowing stills and modified bitumen mixing tanks.[22, 23] For asphalt blowing stills, only afterburners or some other type of combustion device are known to be used as the final control device.

Afterburners are classified as either thermal (i.e., direct flame) or catalytic. The primary advantage of catalytic afterburners is that they use much less supplemental fuel than an equivalent thermal afterburner. Catalytic afterburners are not used or recommended for control of hydrocarbon emissions from asphalt roofing plants because the catalyst is subject to rapid poisoning and plugging due to constituents of the fumes from asphalt processes.[24]

Thermal afterburners destroy combustible pollutants through oxidation to CO_2 and water. Temperatures of 650° to 760°C (1200° to 1400°F), maintained for 0.1 to 0.3 seconds of fume residence time, are sufficient to obtain nearly complete oxidation of most combustible pollutants.[24] Destruction of most hydrocarbons occurs rapidly at 593° to 649°C (1100° to 1200°F), but destruction of some organic compounds, such as methane, and the oxidation of CO to CO_2 requires longer residence times and higher temperatures. Temperatures of 760° to 816°C (1400°to 1500°F) may be required if the methane content of the hydrocarbon is over 1000 ppm.[24] Large droplets (50 to 100 um) require longer residence times at the above temperatures; however, these large droplets are also easily removed in simple cyclones and knockout vessels.[24]

The steps involved in dilute fume incineration are shown schematically in Figure 4-8. As shown in the figure, part of the fume stream is sometimes bypassed around the fuel combustion process to preclude flame quenching and combustion instability. The fume not used for combustion must then be mixed with the hot combustion products to give a uniform temperature to all fume flowing through the afterburner. This mixing should be done as rapidly as possible without causing flame quenching so that sufficient residence time can be provided at the required temperature. Temperature and residence time

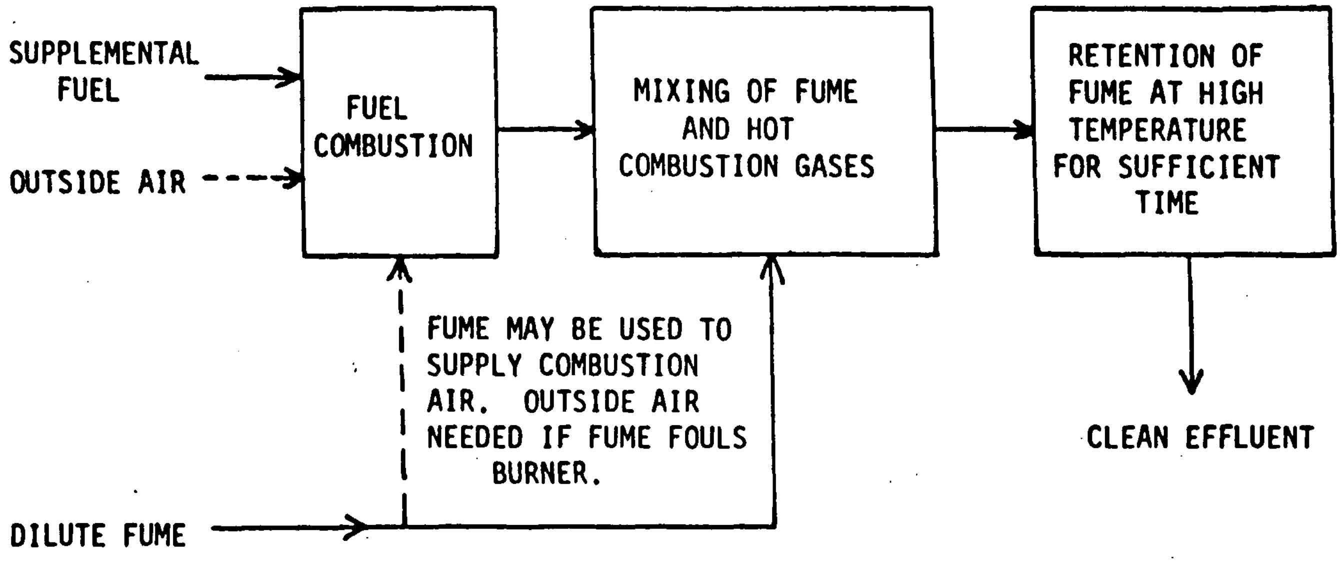

Figure 4-8. Steps required for successful incineration of combustible dilute fumes in a thermal afterburner.[25]

are somewhat interchangeable; a higher temperature allows use of a shorter residence time and vice versa. This is illustrated in Figure 4-9, which indicates that, for a 0.1-second residence time, the efficiency of pollutant oxidation varies from 90 percent at 666°C (1231°F) to 100 percent at 725°C (1337°F). For a 1.0-second residence time, the efficiency varies from 90 percent at 623°C (1153°F) to 100 percent at 666°C (1231°F).

The typical effect of operating temperature on the effectiveness of thermal afterburner destruction of hydrocarbons is shown in Figure 4-10. The figure shows that the efficiency of hydrocarbon destruction varies from about 90 percent to almost 100 percent over a temperature range of about 677° to 760°C (1250° to 1400°F). For a given level of pollutant destruction for different afterburner designs, the major factor that influences the residence time required at a given operating temperature [above about 538°C (1000°F)] is the effectiveness with which the fume is mixed with the combustion products. If hydrocarbons are present in the exhaust gas of any afterburner operating at a nominal combustion chamber temperature above 760°C (1400°F) [or above 649°C (1200°F) for all but a few hydrocarbons], it is due to poor mixing and nonuniform treatment of the fume stream or too short residence time of the fume at temperature. Typically, afterburners are designed with average residence times which vary from 0.1 to 0.5 seconds, but the amount of time required to raise the cold fume up to the desired temperature often exceeds this average residence time. Also, not all portions of the fume are in the combustion chamber an equal amount of time; some portions are swept out very quickly while others are retained for an appreciable time. The variation in residence time, which is a function of flow patterns in the combustion chamber, can appreciably affect afterburner performance. In practice, operating personnel compensate for deficiencies in design by increasing the operating temperature of the thermal afterburners during the startup phase until a temperature is reached which produces the desired pollutant destruction.

The major distinguishing feature of thermal afterburners, as compared to noncombustion control techniques for hydrocarbons, is the use of fuel. Because exhaust gases from the afterburner are typically at 649° to 816°C (1200° to 1500°F), many asphalt roofing plants use heat exchangers to recover the waste heat. This recovered waste heat may be used for many of the plant processes, often the preheating of asphalt.

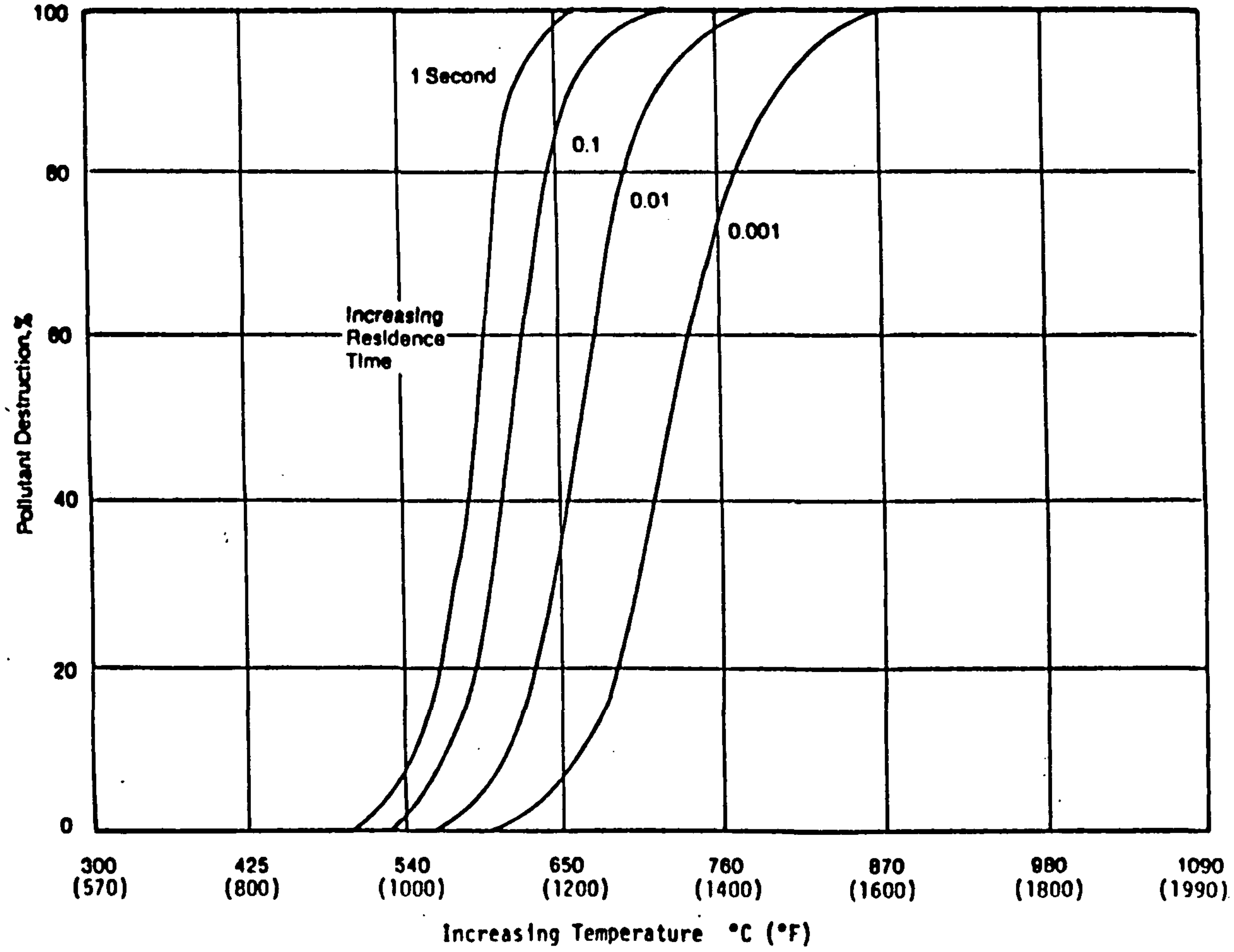

Figure 4-9. Coupled effects of time and temperature on rate of pollutant oxidation.[26]

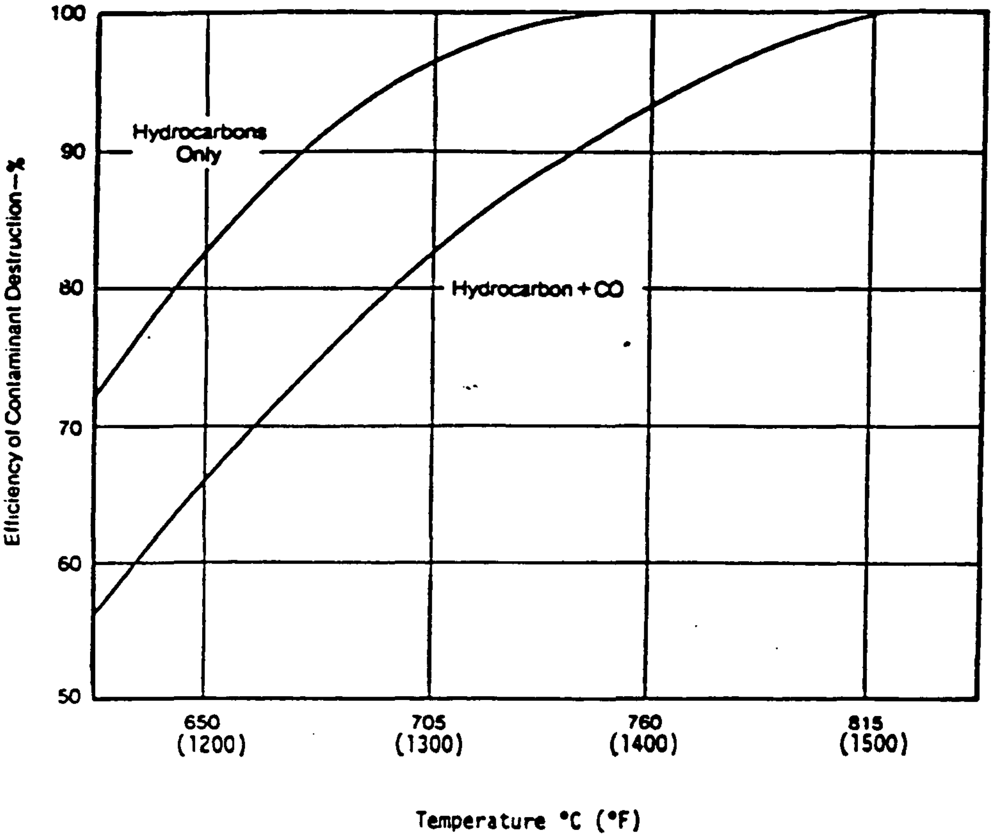

Figure 4-10. Typical effect of operating temperature on effectiveness of thermal afterburner for destruction of hydrocarbons and carbon monoxide.[27]

Thermal afterburners, like all combustion sources, have the potential for generating secondary pollutants due to oxidation of nitrogen, sulfur, and metals in the fume or fuel. Thermal afterburners, in comparison with power plant boilers and industrial furnaces, should have lower NO_x emissions because of their lower operating temperatures. The low operating temperatures and dilution of combustion products by excess air and fume results in a NO_x effluent concentration of 5 to 15 ppm when controlling saturator emissions.[28] Emissions of SO_2 depend on the sulfur content of the fuel burned and on the sulfur content of the fume because almost 100 percent of this sulfur will be converted to SO_2.

4.2.4 Electrostatic Precipitators (ESP)

Low voltage electrostatic precipitators (ESP) can be used to control inorganic and hydrocarbon particulate mass emissions from asphalt saturators, wet loopers, and coaters, and modified bitumen mixing tanks and impregnation vats.[29] The modular electrostatic precipitator typically used in the asphalt roofing industry is illustrated in Figures 4-11 and 4-12. The basic building block of the modular ESP incorporates a prefilter, ionizer, collecting cell, afterfilter, and a solid-state power pack in a self-contained unit. The collecting components slide out for easy cleaning. The contaminated air stream first passes through the mechanical prefilter, which consists of a fiberglass mat or a continuous self-cleaning metallic filter, to remove the larger particulates. A single large prefilter is generally used in the roofing industry rather than the modular type shown in Figures 4-11 and 4-12. The contaminated stream next passes through an ionizer section where it is subjected to an intense electrostatic field (12,000 volts) resulting in an electrical charge being imparted to the particles. The ionized particles are then collected on oppositely charged plates in the collecting cell. The function of the afterfilter is to aid in air distribution and to prevent reentrainment of any particulate draining off the collecting cells. The liquids collected on the plates and afterfilter are drained to a sump and recovered. In this design each module has its own power supply; therefore, a power pack failure will affect only one module. Modules can be removed individually for cleaning or servicing without shutting down the ESP. Because the individual module

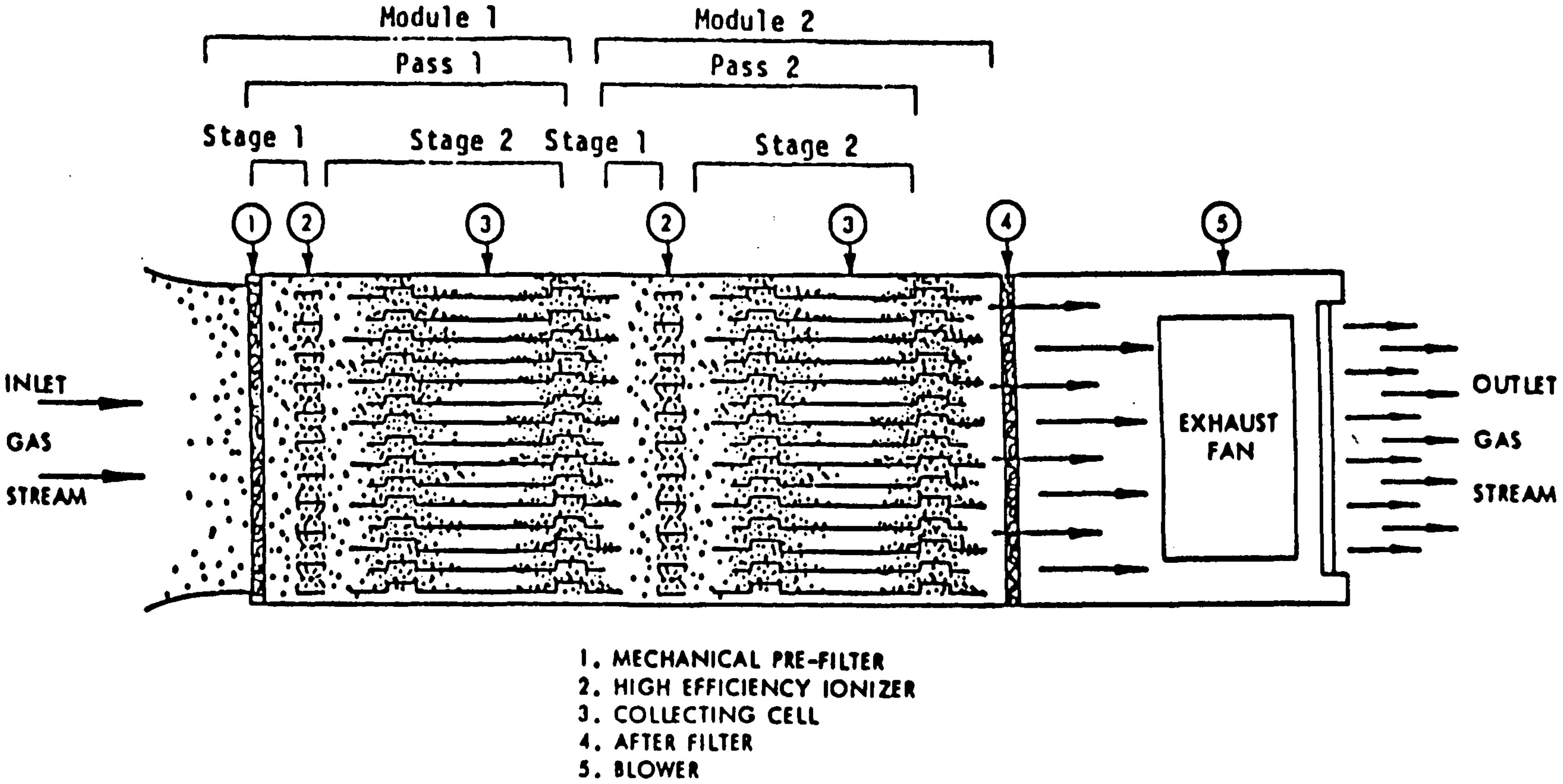

Figure 4-11. Schematic of a two-pass modular electrostatic precipitator.[30]

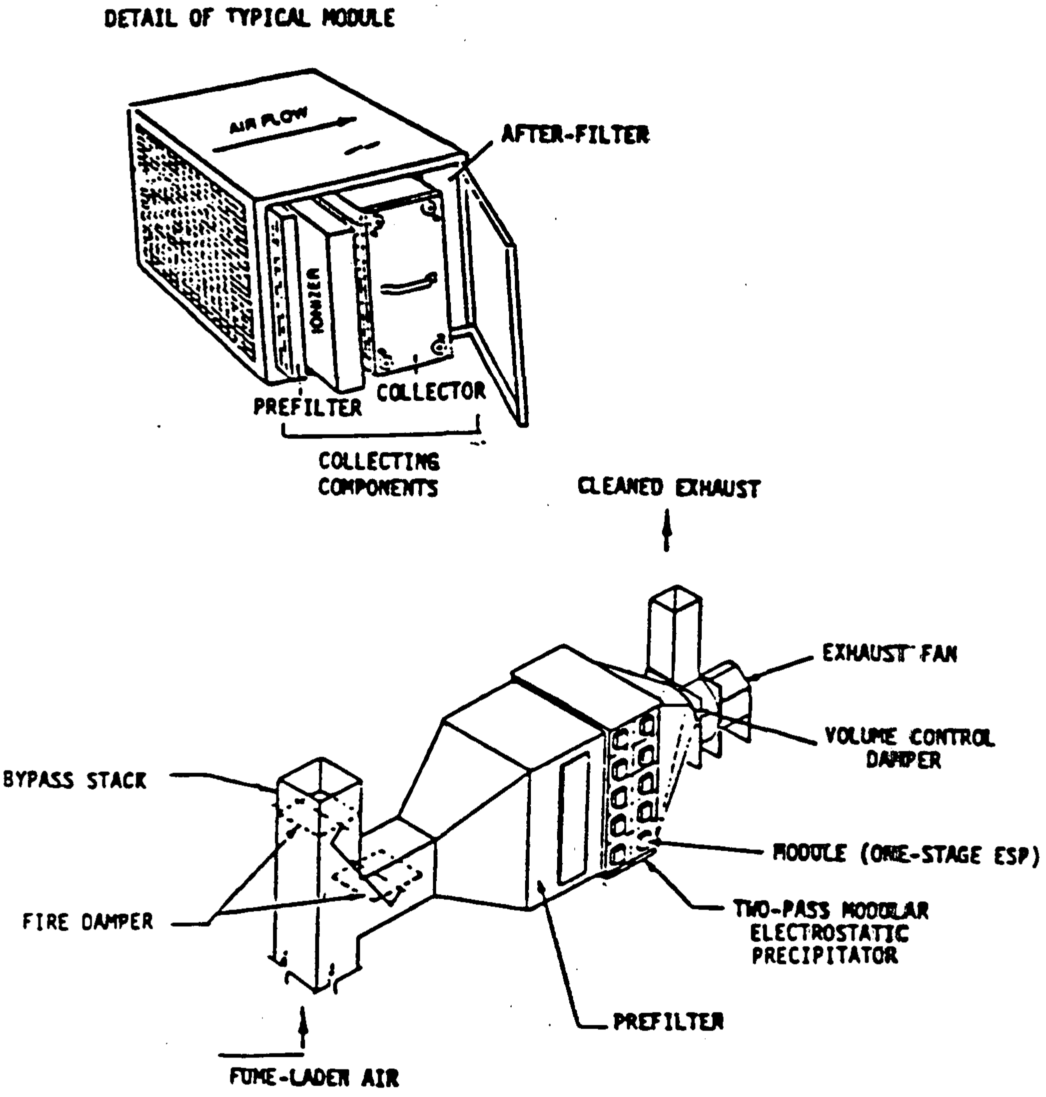

Figure 4-12. Modular electrostatic precipitator.[31]

components can be submerged in a detergent or solvent bath for washing, the potential exists for more effective cleaning; thus the design efficiency can be maintained.

The variables which affect the collection efficiency of the low voltage ESP are particle size, particle resistivity, area of the collecting electrodes, gas temperature, and gas velocity.[32]

The larger particles are easier to collect. High resistivity particles can form an insulating layer on the surface of the collecting electrode. If this happens, the particles will leave the electrode and reenter the gas stream. The area of the collection electrodes is used in the calculations to determine the size and to predict the efficiency of the ESP. In organic liquid particulate, the fume temperature determines the percentage of the fume present as a particulate to be collected. The gas flow is critical; if the gas velocity exceeds the design gas velocity, some particles could be reintroduced in the gas stream.[33] One advantage of the modular ESP is that, to some extent, the above variables can be compensated for by adding more modules in series or in parallel. For example, the modular ESP shown in Figure 4-12 is a two-pass system since the gas must pass through two modules in series. Each module, in turn, is a two-stage precipitator because the fumes are ionized and collected sequentially (these operations are performed simultaneously in a single-stage precipitator).[33] Three-pass systems are sometimes used to control emissions from sources in the asphalt roofing industry.

In order to increase the efficiency of the ESP, precooling of the gas is recommended. Precooling can be accomplished by the use of dilution air, a prechamber using water sprays, or a shell and tube heat exchanger. The advantages and disadvantages of these three methods are discussed in detail in Section 4.2.1.

Advantages of the ESP are its low power consumption and low system pressure drop. Power requirements of the ESP are about 100 W maximum per 0.472 m^3/s (1,000 acf/min) of exhaust flow at a pressure drop of 50 to 150 Pa (0.2 in. to 0.6 in. of water). A typical modular ESP installed at an asphalt roofing plant requires 22.4 kW (30 fan hp) to provide draft.[33]

Disadvantages of the modular ESP include lack of control of gaseous emissions; the problems associated with the handling and cleaning of the collecting components, disposal of the single-use prefilter, and cleaning of the reusable filter now in use at some installations.

4.2.5 Fabric Filters

The handling of sand, talc, mineral stabilizer (filler), granules, and mica causes emissions of inorganic particulates during receiving, storage, transfer, and application operations. Emissions from those operations involving granules may be minimized by purchase of granules which have been washed and oiled (or dyed). Emissions involving the other materials are controlled by transfer within closed systems, capture of emissions at the area of application (via hoods or enclosures), and the venting of these emissions to fabric filter collectors.

Although tests of baghouses collecting these emissions at asphalt roofing plants were not performed during the original NSPS development, it is well documented that fabric filters used in other operations collecting dust from like materials have collection efficiencies in excess of 99 percent.[34] Outlet grain loadings, recorded during emission tests at several crushed stone facilities processing and handling a variety of types of rock seldom exceeded 2.28×10^{-5} kg/m^3 (0.01 gr/DSCF), and visible emissions from the baghouse stack were consistently zero.[34]

There are three basic designs used in fabric filter baghouse construction: the open pressure, the closed pressure, and the closed suction baghouse. The fans for both the open and closed pressure baghouses are located on the dirty gas side of the system. The fan for the closed suction baghouse is located on the discharge or clean side of the baghouse. There are two major bag shapes, the envelope and the tube, and they are constructed of woven cloth or felt cloth. Several materials are used: wool, cotton, synthetics, and fiberglass.

There are several methods of cleaning filter cloths in a baghouse. Fabric flexing and reverse air flow through the bag are the two general methods of bag cleaning. Manual shaking, mechanical shaking, and air shaking are the three methods considered as fabric flexing. Air shaking can be accomplished four ways: air bubbling, jet pulsing, reverse air flexing, and sonic vibration.

Reverse air flow is divided into three methods: repressuring cleaning, atmospheric cleaning, and reverse jet cleaning. Typical air to cloth ratios in conventional baghouses vary from 0.5 to 1.0 $m^3/s/m^2$ (1.0 to 2.0 $ft^3/min/ft^2$) for fumes.

4.3 REFERENCES

1. U.S. Environmental Protection Agency. Asphalt Roofing Manufacturing Industry - Background Information for Proposed Standards. EPA-450/3-80-021a. June 1980. Pages 4-5 to 4-8.

2. Reference 1, Pages 4-8 to 4-27.

3. Reference 1, Page 4-2.

4. Reference 1, Page 4-7.

5. Letter and attachments from Hughes, J.W., U.S. Intec, Incorporated, to Farmer, J.R., EPA. April 8, 1987. Response to Section 114 letter on asphalt processing and asphalt roofing manufacture.

6. Memo from Michelitsch, D.M., EPA: ISB, to Durkee, K.R., EPA: ISB. May 5, 1987. Report on March 1987, trip to U.S. Intec, Inc., North Branch, New Jersey.

7. Reference 1, Page 4-10.

8. Reference 1, Page 4-9.

9. Reference 1, Page 4-11.

10. Reference 1, Page 4-12.

11. Reference 1, Page 4-14.

12. Product literature from Dougald, C.N., Monsanto Enviro-Chem, to Michelitsch, D.M., EPA. March 6, 1987. Mist Eliminator Systems.

13. Materials from Behnke, R., Nord Bitumi U.S., Inc., to Michelitsch, D.M., EPA. May 8, 1987. Response to Section 114 letter on asphalt processing and asphalt roofing manufacture.

14. Reference 1, Page 4-13.

15. Reference 1, Page 4-17.

16. Memo from Michelitsch, D.M., EPA: ISB, to Durkee, K.R., EPA: ISB. February 3, 1987. Report on November 1986, trip to Georgia-Pacific Corporation, Hampton, Georgia. p. 4.

17. Reference 12.

18. Memo from Michelitsch, D.M., EPA: ISB, to Durkee, K.R., EPA: ISB. February 3, 1987. Report on November 1986, trip to Woodland Industries, Griffen, Georgia. Attached permit application.

19. Reference 1, Page 4-15.

20. Reference 1, Page 4-16.

21. Reference 12.

22. Reference 5.

23. Reference 6: Attached test reports from Port Arthur, Texas, facility.

24. Reference 1, Pages 4-17 to 4-18.

25. Reference 1, Page 4-19.

26. Reference 1, Page 4-20.

27. Reference 1, Page 4-21.

28. Reference 1, Page 4-22.

29. Letter and attachments from Bright, F., GAF Corporation to Michelitsch, D.M., EPA. May 8, 1987. Revised response to Section 114 letter on asphalt processing and asphalt roofing manufacture.

30. Reference 1, Page 4-24.

31. Reference 1, Page 4-25.

32. Reference 1, Page 4-23.

33. Reference 1, Page 4-26.

34. Reference 1, Page 4-27.

5.0 COMPLIANCE STATUS

5.1 AFFECTED FACILITIES

Thirty-one plants have been identified as having facilities subject to the new source performance standards (NSPS) for asphalt processing and asphalt roofing manufacturing. Information concerning these plants was obtained from EPA's Stationary Source Compliance Division (SSCD), Regional and State agencies, and responses to several Section 114 Information Requests. Table 5-1 lists these plants and their respective affected facilities. Of the 31 plants reported as subject to the NSPS, emissions data were received for 17 of them, only seven of which were complete reports.

5.2 EMISSIONS DATA

Emissions testing is required to demonstrate compliance with the NSPS, which is summarized as follows:

For saturators:

- The concentration of particulate matter in the stack outlet gas stream shall not exceed 0.04 kg/Mg for shingles or mineral surfaced rolls, or 0.4 kg/Mg for saturated felt or smooth surfaced rolls, as determined by EPA Reference Method 5A.
- The opacity of the stack outlet gas stream shall not exceed 20 percent, as determined by EPA Reference Method 9.
- There shall be no visible fugitive emissions from the capture system for more than 20 percent of the time during any period of consecutive valid observations totaling 60 minutes, as determined by EPA Reference Method 22.
- The operating temperature of the control device shall be monitored during the performance test.

For blowing stills:

- The concentration of particulate matter in the stack outlet gas stream shall not exceed 0.67 kg/Mg of asphalt charged, with a catalyst added to the still and when No. 2 fuel oil or natural gas is fired in the afterburner; 0.71 kg/Mg of asphalt charged, with a catalyst added to the still and when No. 6 fuel oil is fired in the afterburner; 0.60 kg/Mg of asphalt charged, without an added catalyst and when No. 2 fuel oil or natural gas is fired in the afterburner; and 0.64 kg/Mg of asphalt charged, without a catalyst and when No. 6 fuel oil is fired in the afterburner, as determined by EPA Reference Method 5A.

- The opacity of the stack gas outlet stream shall not exceed 0 percent, as determined by EPA Reference Method 9.
- The operating temperature of the control device shall be monitored during the performance test.

For asphalt storage tanks:

- The opacity of the vent gas outlet stream shall not exceed 0 percent, as determined by EPA Reference Method 9.

For mineral handling and storage:

- The opacity of any emissions shall not exceed 1 percent, as determined by EPA Reference Method 9.

The compliance emissions data collected during this NSPS review is shown in Table 5-1. All of the particulate concentration emissions data that were received during this review were well within the allowable NSPS limits.

For saturators producing saturated felt, the data received from three plants varied from 0.0124 kg/Mg to 0.175 kg/Mg as compared to an allowable emission limit of 0.4 kg/Mg. All of these units were controlled by mist eliminators with induced air precooling or cooling of the exhaust gas via extra length of ductwork.

Three plants reported emissions data from coaters that were producing fiberglass mineral surfaced products. There were no control devices associated with these three coaters, but process modifications were reportedly used to reduce emissions. Particulate emissions from two of these facilities were 0.005 kg/Mg and 0.007 kg/Mg. At the third plant, the combined emissions from the coater and an asphalt surge tank were measured. The emissions from this facility were 0.004 kg/Mg. All three of these facilities had an allowable emission limit of 0.04 kg/Mg. This limit of 0.04 kg/Mg was originally developed for a saturator, wet looper, and coater combination producing organic products. Several States and Regions have simply enforced this same limit for the production of fiberglass products, which uses only the coater.

One plant reported emissions of 0.0015 kg/Mg for a coater controlled by an ESP, but the test methodology for this emissions test appears incorrect. The filter temperature reported is that required by EPA Reference Method 5 (248 ± 25°F), not that for Method 5A (108 ± 18°F) as specified by the NSPS. This higher temperature will result in the escape of some gas phase hydrocarbons that would be condensed and captured at the lower temperature required by Method 5A. Consequently, the particulate emissions concentration reported is most likely a low value.

For two plants, the emissions data were reported for the case where emissions from two different roofing lines were combined and ducted to one control device. In both cases, one of the combined exhausts was from a line consisting of a saturator, wet looper, and coater, while the other line consisted only of a coater. In both cases the emissions limit enforced was 0.04 kg/Mg during the manufacture of both organic and inorganic mineral surfaced products. The particulate emissions concentration measured for the plant using a mist eliminator as the control device was 0.0099 kg/Mg, and that for the plant using a scrubber followed by an HVAF was 0.018 kg/Mg.

Production of modified bitumen is fairly new in the asphalt roofing industry. Since this product was not being produced when the NSPS was developed, there have been uncertainties in interpretations and inconsistencies in enforcement of the NSPS among the regulatory agencies when applying the NSPS to these facilities. Consequently, the regulation is not being uniformly enforced for the production of modified bitumen, and limited compliance data are available. Data were, however, received for emissions tests at three modified bitumen production plants. In each case, the product was interpreted as being similar to smooth surfaced roll roofing, and the affected facility was classified as a saturator with an allowable emissions limit of 0.4 kg/Mg. At one plant, the affected facility was defined as the impregnation vats (which were uncontrolled), and average uncontrolled particulate emissions were 0.03 kg/Mg. At the other two modified bitumen production plants, the affected facility was defined as the mixing tanks and the impregnation vats combined. One of these two plants used an oversized ESP, which was retrofit, to control emissions. Particulate emissions from this plant were 0.061 kg/Mg. The other plant used a series of household furnace filters as the control device and controlled emissions were measured at 0.06 kg/Mg.

Emissions data were received from testing performed at eight blowing stills controlled by afterburners. Emissions from three of these facilities ranged from 0.015 kg/Mg to 0.043 kg/Mg as compared to an allowable limit of 0.60 kg/Mg.

An emissions concentration of 0.073 kg/Mg was reported for one blowing still with an allowable limit of 0.64 kg/Mg. Because the fuel used in the afterburner was not reported, the allowable emissions limit for three of the blowing stills is not known, but the controlled emissions of 0.011 kg/Mg, 0.016 kg/Mg, and 0.021 kg/Mg were all well below any of the possible NSPS limits.

The information for one blowing still was not sufficient to determine emissions per mass of product (which is the required format of the standard). The test procedure for this facility also appears to have been performed incorrectly. The test description in the report states that EPA Method 5 was used and not Method 5A as required. However, the actual filter temperatures reported are those used for Method 5A. The other difference in the test methods is the solvent used; Method 5 uses acetone, Method 5A uses trichloroethane, and this test report does not clearly identify which solvent was actually used.

As discussed above, all the reported emissions data for testing at blowing stills was well below the NSPS limitations. The afterburner operating characteristics for these units are summarized in Table 2. During the original NSPS development process, the highest emissions from testing of a blow still were 0.55 kg/Mg, for a blow still controlled by a natural gas fired afterburner operating at 1500°F. This resulted in the NSPS limit of 0.60 kg/Mg. The other allowable limits for the NSPS were developed to account for fuel oil and/or catalyst use by simply adding the particulate contribution from the oil or catalyst to the emissions data obtained from the gas fired afterburner.

Opacity information was included in thirteen of the 17 compliance data reports. Of these seven, opacities ranging from 0 to 5 percent were reported for four saturators; opacities from two coater installations were reported to be between 1.7 and 15 percent; and opacities from two modified bitumen plants were reported to be between 0 and 5 percent. The opacities at six blowing stills were all reported as 0 percent.

Visible emissions data from capture systems was reported for four facilities; all of which were in compliance (no visible emissions for more than 12 minutes in a 60 minute observation period). Nine reports included the required temperature monitoring data for control devices. Compliance data for mineral handling and storage or asphalt storage was received for one plant during the NSPS review (only opacity limits apply to these facilities).

TABLE 5-1
COMPLIANCE STATUS OF ASPHALT PROCESSING AND ASPHALT ROOFING MANUFACTURING PLANTS

		Compliance Data				
Plant	Affected Facility	PM Conc. (kg/Mg)	Opacity (%)	Fugitive Emissions	Temperature Monitoring	Comments
Georgia-Pacific Hampton, GA[1,2]	Saturator	Avg. 0.175	1.0	Comply	Inc. w/test	Product is saturated felt, control device is a mist eliminator.
	Filler Storage	N/R	NDR	N/R	N/R	
Georgia-Pacific Daingerfield, TX[1]	Saturator	Avg. 0.0124	3.5	NDR	Inc. w/test	Product is saturated felt, control device is a mist eliminator.
	Filler Storage	N/R	NDR	N/R	N/R	
Woodland Industries Griffen, GA[2]	Saturators (2)	Avg. 0.089	5.0	Comply	Inc. w/test	Product is saturated felt, one mist eliminator controls both saturators.
Tamko Asphalt Products, Inc. Frederick, MD[3,4]	Saturator	Avg. 0.018	0	NDR	NDR	A scrubber and HVAF controlled two lines during the test; one is a saturator/wet looper/coater, and one is a coater only. The saturator is the subject facility. The products are organic roll roofing and inorganic shingles.
Tamko Asphalt Products, Inc. Joplin, MO[5]	Coater	Avg. 0.0099	1.7	Comply	NDR	A mist eliminator unit was controlling two lines during test. One is a saturator/wet looper/coater and one is a coater only. The coater only line is subject. Both organic and inorganic shingles were being produced.
	Asphalt Storage	N/R	NDR	N/R	N/R	
	Filler Handling & Storage	N/R	NDR	N/R	N/R	
	Parting Agent Storage & Handling	N/R	NDR	N/R	N/R	
	Blowstills (3)	NDR	NDR	N/R	NDR	Incinerators fired with natural gas.
Owens Corning Fiberglas Corp. Summit, IL[6]	Coater	Avg. 0.004	NDR	NDR	N/R	Uncontrolled emissions (with process modifications) from both coater and asphalt surge tank combined were tested. Fiberglass products. Allowable emissions of 0.04 kg/Mg.
	Asphalt Storage (Surge)	N/R	See Comments	N/R	N/R	
Owens Corning Fiberglas Corp. Irving, TX[6]	Coater	Avg. 0.007	NDR	NDR	N/R	Uncontrolled unit (with process modifications). Fiberglass products. Allowable emissions of 0.04 kg/Mg.
	Blowstills (2)	Avg. 0.016	NDR	N/R	NDR	Average of three test runs on incinerator (waste heat boiler), two runs on only one still, one run on both. Fuel unknown.
	Parting Agent Storage	N/R	NDR	N/R	N/R	
	Filler Storage & Handling	N/R	NDR	N/R	N/R	
Owens Corning Fiberglas Corp. Medina, OH[6]	Coater	Avg. 0.005	5 - 15	NDR	N/R	Uncontrolled unit (with process modifications). Fiberglass products. Allowable emissions of 0.04 kg/Mg.
	Blowstill	Avg. 0.043	0	N/R	Inc. w/test	Fuel unknown. Allowable emissions are 0.60 kg/Mg. Incinerator (asphalt preheater) is the control device.
	Parting Agent Storage & Handling	N/R	0	N/R	N/R	
	Filler Storage & Handling	N/R	0	N/R	N/R	
Owens Corning Fiberglas Corp. Ft. Lauderdale, FL[6]	Blowstill	Avg. 0.073	0	N/R	Inc. w/test	Incinerator (asphalt preheater) fired w/fuel oil. Allowable emissions are 0.64 kg/Mg.
Owens Corning Fiberglas Corp. Jacksonville, FL[6]	Blowstill #1	Avg. 0.021	0	N/R	Inc. w/test	The same incinerator (waste heat boiler) controls both stills, apparently at different times. Fuel unknown.
	Blowstill #2	Avg. 0.011	0	N/R	Inc. w/test	
	Parting Agent Handling	N/R	NDR	N/R	N/R	

TABLE 5-1
COMPLIANCE STATUS OF ASPHALT PROCESSING AND ASPHALT ROOFING MANUFACTURING PLANTS

Plant	Affected Facility	Compliance Data				Comments
		PM Conc. (kg/Mg)	Opacity (%)	Fugitive Emissions	Temperature Monitoring	
Owens Corning Fiberglas Corp. Jessup, MD[6]	Blowstill	Avg. 0.02	0	N/R	Inc. w/test	Incinerator (waste heat boiler). Fuel unknown. Allowable emissions are 0.60 kg/Mg.
Tamko Asphalt Products, Inc. Tuscaloosa, AL[7]	Blowstill	Avg. 0.015	0	N/R	Inc. w/test	Incinerator. Allowable emissions are 0.60 kg/Mg. Fired with natural gas.
U.S. Intec, Inc. Port Arthur, TX[8,9]	Modified Bitumen Vats	Avg. 0.03	5	Comply	N/R	Uncontrolled. Product considered smooth roll roofing.
GAF Corporation Mount Vernon, IN[10]	Modified Bitumen Vats & Mixing Tanks	Avg. 0.061	0	NDR	Inc. w/test	One ESP controls mix tanks and vat. Product considered smooth roll roofing. No actual opacity data, just statement of no visible discharge from stack. ESP oversized.
	Blowstill	NDR	NDR	N/R	NDR	
	Filler Handling	N/R	NDR	N/R	N/R	
Nord Bitumi U.S., Inc. Plattsburgh, NY[11,12]	Modified Bitumen Vats & Mixing Tanks	Avg. 0.06	NDR	NDR	N/R	Mix tanks and vat controlled by a series of household furnace filters. Product considered smooth roll roofing.
	Filler Storage	N/R	NDR	N/R	N/R	
GAF Corporation Fontana, CA[10]	Coater	Avg. 0.0015	NDR	NDR	NDR	This data is for an ESP controlling the emissions. The test method, however, appears to be EPA Method 5, not 5A as required. The temperature is Method 5, but it is unknown whether the solvent is that for Method 5 or 5A. Data is then probably a lenient estimate of emissions.
	Filler Handling	N/R	NDR	N/R	N/R	
GAF Corporation Baltimore, MD[10]	Blowstill	Avg. 0.273 (kg/hr)	0	N/R	NDR	The information to determine emissions per mass of product not supplied in test report for this incinerator. Test description states use of EPA Method 5, but actual reports appear to be at Method 5A temperatures. Description of test indicates use of acetone as solvent (as in Method 5, Method 5A uses trichloroethane); actual is unknown. Afterburner is fired with natural gas. Allowable emissions of 0.60 kg/Mg.
	Filler Storage	N/R	NDR	N/R	N/R	
Bird Incorporated Norwood, MA[13]	Saturator	NDR	NDR	NDR	NDR	Work being done to bring saturator into compliance.
	Coater	NDR	NDR	NDR	NDR	
Owens Corning Fiberglas Corp. Houston, TX[6]	Coater	NDR	NDR	NDR	NDR	Uncontrolled
Owens Corning Fiberglas Corp. Kearny, NJ[6]	Coater	NDR	NDR	NDR	NDR	
	Filler Handling & Storage	N/R	NDR	N/R	N/R	
	Parting Agent Handling & Storage	N/R	NDR	N/R	N/R	
Tamko Asphalt Products, Inc. Phillipsburg, KS[14]	Saturators (2)	NDR	NDR	NDR	NDR	
	Blowstill	NDR	NDR	N/R	N/R	Incinerator fired with natural gas. Allowable emissions are 0.60 kg/Mg.
	Asphalt Storage	N/R	NDR	N/R	N/R	
	Filler Handling & Storage	N/R	NDR	N/R	N/R	
	Parting Agent Handling & Storage	N/R	NDR	N/R	N/R	

TABLE 5-1
COMPLIANCE STATUS OF ASPHALT PROCESSING AND ASPHALT ROOFING MANUFACTURING PLANTS

Plant	Affected Facility	Compliance Data PM Conc. (kg/Mg)	Opacity (%)	Fugitive Emissions	Temperature Monitoring	Comments
Ennis Asphalt Ennis, TX[15]	Blowstill	NDR	NDR	N/R	NDR	
Celotex Corporation Goldsboro, NC[16]	Filler Handling & Storage	N/R	NDR	N/R	N/R	
Certainteed Corp. Oxford, NC[16]	Filler Handling	N/R	NDR	N/R	N/R	
Elk Corporation of America Tuscaloosa, AL[17]	Mineral Handling Asphalt Storage	N/R N/R	NDR NDR	N/R N/R	N/R N/R	
Asphalt for Roofing Houston, TX[18]	unknown					
Manville Corp. Ft. Worth, TX[15]	unknown					
SRS Industries Waxahachie, TX[15,18]	unknown					
Tarco Inc. Belton, TX[15,18]	unknown					
Tarco Inc. Waco, TX[18]	unknown					
Texas Refining Corp. Ft. Worth, TX[18]	unknown					

PM - particulate matter
NDR - no data received during this NSPS review
N/R - not required for compliance
Comply - meets fugitive visible emission limit as measured by EPA Method 22

TABLE 5-2
BLOWING STILL AFTERBURNER CHARACTERISTICS[5,6,7,10,14,19]

PLANT	TEMP[a] (°F)	RES TIME (SEC)	EMISSIONS		FUEL TYPE	CATALYST USE	OPERATING TEMPERATURE MONITORING
			ACTUAL (kg/Mg)	ALLOWABLE (kg/Mg)			
OWENS-CORNING FIBERGLAS CORP.							
-Irving, TX	1600	0.55	0.016	NDR	NDR	No	Continuous monitor, and checked once per shift
-Ft. Lauderdale, FL	1200-1600	0.22	0.073	0.64	Oil	No	Continuous monitor, and checked once per shift
-Medina, OH	1400	0.2	0.043	0.60	NDR	CBI	Continuous monitor, and checked once per shift
-Jacksonville, FL	1400	2.3	0.021	NDR	NDR	No	Continuous monitor, and checked once per shift
(One A/B, two stills)	1400	2.3	0.011	NDR	NDR	No	Continuous monitor, and checked once per shift
-Jessup, MD	1400	1.5	0.020	0.60	NDR	No	Continuous monitor, and checked once per shift
TAMKO ASPHALT PRODUCTS, INC.							
-Tuscaloosa, AL	1300	2.0	0.015	0.60	Gas	CBI	Continuous monitor and checked every 15 minutes
-Joplin, MO	1400-1600	0.7	NDR	NDR	Gas	CBI	Plant personnel monitor the temperature
(Four stills, two A/B)	1400-1600	0.7	NDR	NDR	Gas	CBI	Plant personnel monitor the temperature
-Phillipsburg, KS	1200-1600	NDR	NDR	0.60	Gas	No	Plant personnel monitor the temperature
GAF CORPORATION							
-Mt. Vernon, IN	NDR	NDR	NDR	NDR	NDR	No	NDR
-Baltimore, MD	1000	4.7	0.273 (kg/hr)	0.60	Gas	No	Continuous monitor and checked every hour

NDR - no data received during this NSPS review
CBI - confidential business information

a. Temperatures were not always included in test report as required; were obtained by Section 114 Information Request.

5.3 REFERENCES

1. Letter and attachments from Bentley, K.M., Georgia-Pacific Corporation, to Farmer, J.R., EPA. July 14, 1987. Response to Section 114 letter on asphalt processing and asphalt roofing manufacture.

2. Letter and attachments from Shirah, T., Georgia Department of Natural Resources, to Michelitsch, D.M., EPA. January 13, 1987. Information on Georgia asphalt processing and asphalt roofing manufacturing plants subject to the NSPS.

3. Letter and attachments from Swaroop, D., Tamko Asphalt Products, Inc. (Frederick, MD), to Michelitsch, D.M., EPA. April 27, 1987. Response to Section 114 letter on asphalt processing and asphalt roofing manufacture.

4. Materials from Oliver, R., and Frantz, D., Maryland Department of Health and Mental Hygiene, to Michelitsch, D.M., EPA. May 6, 1987. Test report for Tamko Asphalt Products, Inc., August 1984.

5. Materials from Cox, H.M., Tamko Asphalt Products, Inc. (Joplin, MO), to Farmer, J.R., EPA. May 1, 1987. Response to Section 114 letter on asphalt processing and asphalt roofing manufacture.

6. Letter and attachments from Switala, E.D., Owens-Corning Fiberglas Corporation, to Michelitsch, D.M., EPA. May 1987. Response to Section 114 letter on asphalt processing and asphalt roofing manufacture.

7. Materials from Burrows, E.H., Tamko Asphalt Products, Inc. (Tuscaloosa, AL), to Farmer, J.R., EPA. April 17, 1987. Response to Section 114 letter on asphalt processing and asphalt roofing manufacture.

8. Letter and attachments from Hughes, J.W., U.S. Intec, Incorporated, to Farmer, J.R., EPA. April 8, 1987. Response to Section 114 letter on asphalt processing and asphalt roofing manufacture.

9. Memo from Michelitsch, D.M., EPA: ISB, to Durkee, K.R., EPA: ISB. May 5, 1987. Report on March 1987, trip to U.S. Intec, Inc., North Branch, New Jersey. Attached test report of July 8-9, 1986, from the Port Arthur, Texas facility.

10. Letter and attachments from Bright, F., GAF Corporation, to Michelitsch, D.M., EPA. May 8, 1987. Revised response to Section 114 letter on asphalt processing and asphalt roofing manufacture.

11. Memo from Michelitsch, D.M., EPA: ISB, to Durkee, K.R., EPA: ISB. June 3, 1987. Report on March 1987, trip to Nord Bitumi U.S., Inc., Plattsburgh, New York.

12. Materials from Esposito, P.V., EPA Region II, to Michelitsch, D.M., EPA: ISB. January 21, 1987. Test report for Nord Bitumi U.S., Inc., Plattsburgh, New York, June 1985.

13. Letters and attachments from Maloof, R.C., Bird Incorporated, to Michelitsch, D.M., EPA. October 17 and 23, 1986. Discussion of compliance requirements for asphalt roofing.

14. Letter and attachments from Kaumans, W.W., Tamko Asphalt Products, Inc. (Phillipsburg, KS), to Farmer, J.R., EPA. April 15, 1987. Response to Section 114 letter on asphalt processing and asphalt roofing manufacture.

15. U.S. Environmental Protection Agency. Compliance Data System Report. August 5, 1986.

16. Materials from Allen, T., North Carolina Division of Environmental Management, to Michelitsch, D.M., EPA. February 25, 1987. Information concerning North Carolina's asphalt processing and asphalt roofing manufacturing plants subject to the NSPS.

17. Telecon. Sullivan, George, Alabama Department of Environmental Management, with Michelitsch, D.M., EPA. August 15, 1986. Plants in Alabama subject to Subpart UU.

18. Letter and attachments from Wallin, G.I., Texas Air Control Board, to Michelitsch, D.M., EPA. February 20, 1987. Plants in Texas subject to Subpart UU.

19. U.S. Environmental Protection Agency. Asphalt Roofing Manufacturing Industry - Backround Information for Proposed Standards. EPA/3-80-021a. June 1980. p. 6-20.

6.0 COST ANALYSIS

6.1 INTRODUCTION

This chapter presents total capital investment and total annual costs and cost effectiveness in second quarter 1987 dollars of model alternative control systems for the various emitting facilities in asphalt roofing manufacturing plants. Both conventional (i.e., saturated and coated organic felt and coated fiberglass) and modified bitumen process plants are covered. Brief descriptions of the processes and emission points and of the control devices are included; detailed descriptions can be found in Chapter 3 and Reference 1 respectively. In most cases costs and cost effectiveness are developed for two annual operating periods. The emitting facility, pollutant load, alternative control devices and annual operating periods are summarized in Table 6-1.

6.1.1 Process Description - Conventional Process

The manufacture of asphalt roofing is a continuous process performed on a roofing machine "line." A roll of base mat (either non-woven fiberglass or a modified paper "felt") is unwound onto a dry looper or accumulator. The looper acts as a reservoir of base mat and eliminates the need to shut down the line when a new roll of base is added. If an organic (paper) felt is being run, it is saturated with asphalt in the saturator by a series of immersions in asphalt at 470°F (243°C). The organic felt leaves the saturator tank with an excess of saturant on its surface and enters the wet looper where the excess asphalt is drawn into the felt to increase the amount of saturation.

If saturated felt is being produced, the sheet is passed directly to a cool-down section and then wound on rolls. For surfaced roofing products, however, the sheet moves to a coater where a mineral-stabilized coating asphalt is applied to both surfaces. If fiberglass mat is being run, the saturator and wet looper are bypassed; the mat is sent directly to the coater where coating asphalt both coats the fibers and fills the voids between them.

TABLE 6-1

ASPHALT ROOFING MANUFACTURING

MODEL FACILITY PARAMETERS AND CONTROL SYSTEMS

Facility	Description of Control System					Annual Operating Hours	Uncontrolled Emissions		Controlled Emissions		Pollutants Collected		Control Efficiency %	Notes
	Device	Nm^3/s	(scfm)	°C	(°F)		Mg/yr	(tons/yr)	Mg/yr	(tons/yr)	Mg/yr	(tons/yr)		
Saturator, Wet Looper, and Coater (Organic Shingles and Rolls)^{1,2,a}	ESP/HE^b	4.93	(10,450)	38	(100)	4,000	65.89	(72.63)	4.39	(4.84)	61.50	(67.79)	93.3	Model parameters were taken from the original BID - small plant. The control efficiency for the mist eliminator was taken from product literature, and assumed same operating temperature and uncontrolled emissions as the ESP and HVAF. The case of 8,000 hrs/yr operating time was evident in several 114 responses -- as was use of small plant size (by size of control device).
						8,000	131.78	(145.26)	8.78	(9.68)	123.00	(135.58)		
	HVAF/HE^c	4.93	(10,450)	38	(100)	4,000	65.89	(72.63)	4.39	(4.84)	61.50	(67.79)	93.3	
						8,000	131.78	(145.26)	8.78	(9.68)	123.00	(135.58)		
	ME/HE^d	4.93	(10,450)	38	(100)	4,000	65.89	(72.63)	1.98	(2.18)	63.91	(70.45)	97.0	
						8,000	131.78	(145.26)	3.96	(4.36)	127.82	(140.90)		
Saturator and Wet Looper Only (Saturated Felt)	Will assume same as above													
Coater Only (Fiberglass Products) 3, 4, 5, 6	ESP/HE	2.83	(6,000)	38	(100)	4,000	4.99	(5.50)	0.334	(0.368)	4.66	(5.13)	93.3	Temperatures, operating hours, and control efficiencies of ESP and HVAF from original BID. ME control efficiency from product literature. Flow rate from test data in 114 responses from GAF (Fontana, CA), Owens-Corning (Irving, TX, and Medina, OH). The emissions data was derived from the GAF (Fontana, CA) test report. The data was for an ESP controlled coater (the wrong test method was used - Method 5 rather than 5A, but both front and back half catches were included - will likely be a lenient estimate). Uncontrolled emissions were back calculated using efficiency.
						8,000	9.98	(11.00)	0.668	(0.736)	9.32	(10.26)		
	HVAF/HE	2.83	(6,000)	38	(100)	4,000	4.99	(5.50)	0.334	(0.368)	4.66	(5.13)	93.3	
						8,000	9.98	(11.00)	0.668	(0.736)	9.32	(10.26)		
	ME/HE	2.83	(6,000)	38	(100)	4,000	4.99	(5.50)	0.150	(0.165)	4.84	(5.34)	97.0	
						8,000	9.98	(11.00)	0.300	(0.330)	9.68	(10.68)		
Filler Surge and Storage^7	F/F^d	1.37	(2,900)	Ambient		4,000	27.06	(29.83)	0.44	(0.48)	26.63	(29.35)	98.4	Taken from original BID - Medium and Large plants (size of control deivce compared to several 114 responses).
						8,000	54.12	(59.66)	0.88	(0.96)	53.26	(58.70)		
Parting Agent Surge and Storage^8	F/F	0.99	(2,100)	Ambient		4,000	19.60	(21.60)	0.32	(0.35)	19.28	(21.25)	98.4	
						8,000	39.20	(43.20)	0.64	(0.70)	38.56	(42.50)		
Asphalt Storage^9	M/E^f	0.35	(750)	54	(130)	800	1.48	(1.63)	0.03	(0.03)	1.45	(1.60)	98.0	Parameters from original BID - Medium Plant. Control device operates only when roofing line is out of service (during roofing line operation the storage tank emissions are controlled by saturator control device).
						4,800	8.90	(9.80)	0.18	(0.20)	8.72	(9.60)		
Blowing Stills^{10}	A/B W/HR^g	2.83	(6,000)	760	(1400)	2,000	378	(417)	22.7	(25.5)	355.3	(391.5)	93.9	Parameters taken from original BID - small plants (sizes determined by comparison with several 114 responses).

TABLE 6-1

(continued)

Facility	Description of Control System					Annual Operating Hours	Uncontrolled Emissions		Controlled Emissions		Pollutants Collected		Control Efficiency %	Notes
	Device	Nm³/s	(scfm)	°C	(°F)		Mg/yr	(tons/yr)	Mg/yr	(tons/yr)	Mg/yr	(tons/yr)		
Modified Bitumen Mixing 11, 12, 13, 14	ESP/HE	0.94	(2,000)	38	(100)	5,000	10.46	(11.53)	0.70	(0.77)	9.76	(10.76)	93.3	The majority of the modified bitumen parameters are rough estimates, due to limited data. The temperatures and efficiencies came from original BID and product literature. Afterburner temp. and efficiency derived from pg. 4-49 of the BID. Operating hours from 114 responses of Nord Bitumi and U.S. Intec. Control system size and emissions from U.S. Intec 114 response (test data for New Jersey plant). Used inlet to HVAF unit as uncontrolled. It is Method 5, not 5A, but the temperature was at the 5A level. (Only difference was acetone wash rather than TCE). If anything, it is a lenient estimate.
						8,000	16.73	(18.44)	1.12	(1.23)	15.61	(17.21)		
	HVAF/HE	0.94	(2,000)	38	(100)	5,000	10.46	(11.53)	0.70	(0.77)	9.76	(10.76)	93.3	
						8,000	16.73	(18.44)	1.12	(1.23)	15.61	(17.21)		
	ME/HE	0.94	(2,000)	38	(100)	5,000	10.46	(11.53)	0.31	(0.34)	10.15	(11.19)	97.0	
						8,000	16.73	(18.44)	0.50	(0.55)	16.23	(17.89)		
	A/B W/HR	0.94	(2,000)	704	(1300)	5,000	10.46	(11.53)	0.21	(0.23)	10.25	(11.30)	98.0	
						8,000	16.73	(18.44)	0.33	(0.36)	16.40	(18.08)		
Modified Bitumen Impregnation Vats 15, 16, 17, 18, 19	ESP/HE	2.83	(6,000)	38	(100)	5,000	0.839	(0.925)	0.056	(0.062)	0.783	(0.863)	93.3	Temperatures and efficiencies from original BID and product literature. It was assumed that the line was total enclosure hooded and so the same control device size as a conventional coater was used. (The lines I saw weren't total enclosure, which probably lead to their high flow rates - but the original regulation was based on total enclosure, so I will in this case also). Operating hours from U.S. Intec and Nord Bitumi 114 responses. Uncontrolled emissions taken from Method 5A compliance data from U.S. Intec Texas facility (obtained during visit to their New Jersey plant). I chose the number from line #1 as it was the highest of the two (worst case).
						8,000	1.34	(1.48)	0.090	(0.10)	1.25	(1.38)		
	HVAF/HE	2.83	(6,000)	38	(100)	5,000	0.839	(0.925)	0.056	(0.062)	0.783	(0.863)	93.3	
						8,000	1.34	(1.48)	0.090	(0.10)	1.25	(1.38)		
	ME/HE	2.83	(6,000)	38	(100)	5,000	0.839	(0.925)	0.025	(0.028)	0.814	(0.897)	97.0	
						8,000	1.34	(1.48)	0.040	(0.040	1.30	(1.44)		

[a] Parameters for saturated felt manufacture (using the saturator and wet looper only) are assumed to be identical to those for manufacture of organic shingles and rolls using the saturator, wet looper and coater

[b] ESP/HE = electrostatic precipitator with cooling system

[c] HVAF/HE = high velocity air filter with cooling system

[d] ME/HE = mist eliminator with cooling system

[e] F/F = fabric filter

[f] ME = mist eliminator

[g] A/B W/HR = afterburner with heat recovery

REFERENCES FOR TABLE 6-1

1. U.S. Environmental Protection Agency. Background Information for Proposed Standards: Asphalt Roofing Manufacturing Industry. EPA 450/3-80-021a. June 1980. pp. 8-82, 8-85 through 8-87.

2. Product literature from Dougald, C.N., Monsanto Enviro-Chem, to Michelitsch, D.M., EPA. March 6, 1987. Mist Eliminator Systems.

3. Reference 1.

4. Reference 2.

5. Letter and enclosures from Bright, F.W., GAF Corporation, to Michelitsch, D.M., EPA. May 8, 1987. Enclosure 4. Revised response to Section 114 letter on asphalt processing and roofing manufacture.

6. Letter and enclosures from Switala, E.D., Owens-Corning Fiberglas Corporation, to Michelitsch, D.M., EPA. May 4, 1987. Enclosures 5 and 10. Response to Section 114 letter on asphalt processing and roofing manufacture.

7. Reference 1.

8. Reference 1.

9. Reference 1, pp. 6-20 through 6-22, 8-73, 8-82, 8-85 through 8-87.

10. Reference 1.

11. Reference 1, pp. 4-49, 8-85 through 8-87.

12. Reference 2.

13. Letter and enclosures from Behnke, R., Nord Bitumi U.S., Inc., to Michelitsch, D.M., EPA. May 15, 1987. p. 3. Revised response to Section 114 letter on asphalt processing and roofing manufacturing.

14. Letter and enclosures from Hughes, J.W., U.S. Intec, Inc., to Farmer, J.R., EPA. April 8, 1987. Enclosures 3 and 4, and test report from Branchburg, NJ. Response to Section 114 letter on asphalt processing and roofing manufacture.

15. Reference 1, p. 8-85 through 8-87.

16. Reference 2.

17. Reference 13.

18. Reference 14.

19. Memo and attachments from Micheltisch, D.M., EPA:ISB, to Durkee, K.R., EPA:ISB. May 5, 1987. Report on March 1987 trip to U.S. Intec, Inc., North Branch, New Jersey. Attached test reports from U.S. Intec facility in Port Arthur, Texas.

The coating material is a mixture made at the roofing plant of coating asphalt (usually a more viscous material with a higher softening point than saturant asphalt) and a mineral stabilizer, frequently ground limestone.

Following coating, mineral surfacing is applied. If smooth surfaced roll roofing is being made, both sides are covered with parting agent, usually talc. If granule-surfaced products are being manufactured, the top surface of the sheet is covered with mineral granules while parting agent is applied to the back. The sheet is then accumulated on a finish looper where it cools to the point where it can be cut and packaged.

Both coating and saturant asphalt are prepared by sparging crude asphalt with air in a (usually) batch "blowing still" at 400 to 470°F (204 to 243°C). The air partially oxidizes the asphalt increasing its softening temperature and modifying other characteristics.

6.1.1.1 Process Emissions. Inorganic particulate emissions result from both filler and parting agent handling and transfers. Particulate and gaseous hydrocarbons are emitted by the saturator/wet looper/coater, asphalt storage, and the blowing still.

6.1.2 Process Description - Modified Bitumen Process

Modified bitumen process roofing is used for single ply industrial and commercial roofs. Modified bitumen compound is prepared by mixing asphalt with atactic and isotactic polypropylene or styrene-butadiene-styrene and a ground mineral stabilizer such as talc, limestone or slate at 356°F (180°C). A polyester or fiberglass mat is impregnated with the compound by successive immersions and passing through a set of rollers, which meter the thickness, in a vat. Following impregnation the sheet is cooled by floating on a water filled tray and a polypropylene backing sheet or mineral surfacing is applied to the still hot top side. Cooling is completed by submerging it in more water cooling trays or by water sprays. The cooled sheet is dried with a fan and talc is applied. Following an accumulator section, the sheet is wound on rolls for sale.

6.1.2.1 Emissions - Modified Bitumen Process. Inorganic particulates are emitted from mineral storage and handling, just as in the conventional process. The modified bitumen mixing tanks and impregnation vats emit particulate and gaseous hydrocarbons.

6.1.3 Model Control Descriptions

For each of the emission sources, the waste gas volume, pollutant loadings and alternative control systems used are shown in Table 6-1. For the Saturator, Wet Looper and Coater, the proposed control devices are an Electrostatic Precipitator (ESP), a High Velocity Air Filter (HVAF) and a Mist Eliminator (ME). The emitted hydrocarbons at 470°F (243°C) are both gaseous and particulate. Cooling the gas stream to 100°F condenses most of the volatile organic pollutants and allows the proposed control devices (which have no ability to collect gases) to remove the volatile organic pollutants from the gas stream. Hence each collector is preceded by a cooling section.

A two-stage (that is, the ionizing and collecting sections are sequential rather than together) triple pass (three two-stage modules in series) ESP was estimated for this study. Three passes provide for moderate fouling without loss of overall collection efficiency. Such units can be obtained skid-mounted with all piping, wiring and controls in place. An advantage of the ESP is very low pressure drop (<1 in H_2O) which reduces fan power costs.

While the lighter less viscous fraction of the pollutant drains from the ESP plates, the heavier ends gradually collect on the plates and reduce efficiency. Most of the fouling occurs on the first pass; three passes allow moderate fouling without loss of collection efficiency. Eventually, cleaning is required. Two approaches were estimated: manual, where the cells are removed and cleaned by dipping or soaking in a solvent or detergent solution, and automatic in-place, where a detergent solution is sprayed on the cells by a column of nozzles which traverses the cell bank.

The HVAF utilizes a roll of fiberglass mat filter media which collects the entrained hydrocarbons by impaction. The mobile fraction migrates through the filter, coalesces, is re-entrained, passes through the exhaust fan and is collected by a mesh mist eliminator at the fan discharge. The more viscous fraction collects on the filter media, eventually blinding it. The filter media is automatically advanced when the pressure drop reaches a predetermined level or after a predetermined time. The used filter media is accumulated in a roll. These units can be obtained partially preassembled and prewired, requiring more installation work at the site than the usual skid-mounted unit. A disadvantage of the HVAF is a relatively high (26-30 in H_2O including the mesh mist eliminator) pressure drop which results in high fan power costs.

A densely packed bed of fiberglass which collects entrainment by interception and coalescence is the principle utilized by the Mist Eliminator. The media is usually arranged in vertical "candles" which gradually foul and must be replaced or repacked. Pressure drop is 12-15 in H_2O, intermediate between the ESP and HVAF.

When a fiberglass mat base material is used on the roofing line, the saturator and wet looper are bypassed, hence only the coater emissions must be controlled. The emissions are similar to those produced by the combined saturator wet looper and coater, but the waste gas flow and the hydrocarbon loading are lower. Proposed control devices are identical.

Filler and parting agent surge and storage emissions are at ambient temperature and are solely inorganic particulate. Control for each is by fabric filter (baghouse).

Asphalt storage is normally vented to the saturator, wet looper and coater control device. However when the line is down, a separate mist eliminator is used to control emissions.

Blowing stills are the heaviest emitting devices in asphalt roofing manufacture. Emissions are controlled by an afterburner. The heat content of the combustion gas is used to minimize fuel consumption by heating incoming asphalt.

Modified bitumen mixing process emissions are controlled by the same devices used to control the saturator, wet looper and coater in the conventional process. In addition, costs were developed for an afterburner.

Modified bitumen impregnation emissions are distinguished by the low pollutant load compared to the conventional process saturator, but the same control devices are proposed.

6.2 COST DATA, METHODOLOGY AND ASSUMPTIONS

6.2.1 Capital Costs

Capital costs include the purchased equipment cost and the direct and indirect costs of installation. The purchased equipment cost includes the cost of both major equipment items and auxiliaries such as instrumentation, pumps, and heat exchangers and the cost of taxes and freight. Direct installation costs include foundations, erection, electrical, piping and similar charges. Indirect costs are those associated with engineering and supervision, construction fees, and start up tests.

All capital costs include duct work, control device, fan, instrumentation and controls. Systems for the Saturator Wet Looper and Coater, Coater Only and Modified Bitumen Process Impregnation also include total enclosure hoods. Alternative capital cost estimates were prepared for the ESP's HVAF's and ME's: one with an evaporative recirculating precooler and a second with a finned tube precooler. In addition, the capital costs for the ESP's were estimated with manual and with automatic in-place cleaning. These estimates are given in Tables 6-2, 6-3, and 6-4. The costs for the evaporative recirculating and finned tube precoolers and for the hoods are presented separately in Tables 6-5 and 6-6, respectively.

Vendors' costs for HVAF's, ESP's, and ME's were obtained as budget quotes from vendors (References 2, 3, and 4 respectively). Baghouse costs were estimated using the data and procedures in References 5 and 6. The blowing still afterburner with heat recovery (A/BWH/R) cost was estimated using procedures and data given in Reference 5. A vendors quote (Reference 7) was obtained for the modified bitumen process afterburner since it fell outside the size range covered by the procedures in Reference 5. Asphalt heaters were estimated using data from Reference 8. Auxiliary equipment such as ductwork, fans, motors and starters, was estimated as necessary as described in References 9 and 13. The cost of a second set of cells for the ESP and the Automatic Cleaning Machine Cost was obtained from the vendor's representative (Reference 10). Freight costs were estimated at 5 percent of the equipment cost, taxes at 3 percent in all cases (Reference 5).

TABLE 6-2
CAPITAL COST: ELECTROSTATIC PRECIPITATOR, HIGH VELOCITY AIR FILTER AND MIST ELIMINATOR CONTROL SYSTEMS - EVAPORATIVE RECIRCULATING PRECOOLER

			Cost (thousand $)							
	System Capacity(2)		Electrostatic Precipitator(4)				High Velocity Air Filter		Mist Eliminator(3)	
			Automatic Cleaning		Manual Cleaning					
Facility	Nm^3/s	scfm	Purchased Equipment	Total Capital Investment	Purchased Equipment	Total Capital Investment	Purchased Equipment	Total Capital Investment	Purchased Equipment	Total Capital Investment
Saturator(1) Wet Looper & Coater	4.93	10,450	119	196	116	191	130	204	170	243
Fiberglass(1) Mat Coater	2.83	6,000	100	153	96	147	101	154	132	184
Modified(5) Bitumen Mixing	0.94	2,000	39	61	38	59	55	85	69	94
Modified(1) Bitumen Impregnation	2.83	6,000	89	135	85	129	97	145	128	175

(1) Costs include ductwork, precooler, fan, and total enclosure hood, stack and instrumentation and controls.

(2) Nm^3/s = Normal cubic meters per second; volume is calculated at 70°F (21°C) and 1 atm. (101.3 kPa).
scfm = standard cubic feet per minute; volume is calculated at 70°F (21°C) and 1 atm. (101.3 kPa).

(3) Cost includes spare element set.

(4) Cost includes either an automatic cleaning device or a spare cell set (manual cleaning).

(5) Costs include ductwork, precooler, fan, stack and instrumentation and controls.

TABLE 6-3

CAPITAL COST: ELECTROSTATIC PRECIPITATOR, HIGH VELOCITY AIR FILTER AND MIST ELIMINATOR CONTROL SYSTEMS - FINNED TUBE PRECOOLER

			Cost (thousand $)							
	System Capacity(2)		Electrostatic Precipitator(4)				High Velocity Air Filter		Mist Eliminator(3)	
			Automatic Cleaning		Manual Cleaning					
Facility	Nm^3/s	scfm	Purchased Equipment	Total Capital Investment	Purchased Equipment	Total Capital Investment	Purchased Equipment	Total Capital Investment	Purchased Equipment	Total Capital Investment
Saturator(1) Wet Looper & Coater	4.93	10,450	119	174	116	169	130	182	170	221
Fiberglass(1) Mat Coater	2.83	6,000	96	131	92	125	95	129	126	161
Modified(5) Bitumen Mixing	0.94	2,000	36	49	35	47	51	73	59	82
Modified(1) Bitumen Impregnation	2.83	6,000	89	122	85	116	97	132	128	162

(1) Costs include ductwork, precooler, fan, total enclosure hood, stack and instrumentation and controls.
(2) Nm^3/s = Normal cubic meters per second; volume is calculated at 70°F (21°C) and 1 atm. (101.3 kPa).
scfm = standard cubic feet per minute; volume is calculated at 70°F (21°C) and 1 atm. (101.3 kPa).
(3) Cost includes spare element set.
(4) Cost includes either an automatic cleaning device or a spare cell set (manual cleaning).
(5) Costs include ductwork, precooler, fan, stack and instrumentation and controls.

TABLE 6-4

CAPITAL COST: FABRIC FILTER AND AFTERBURNER WITH HEAT RECOVERY AND ASPHALT STORAGE MIST ELIMINATOR CONTROL SYSTEMS

Second Quarter 1987 Dollars

	System Capacity(2)		Cost (thousand $)(1)					
			Fabric Filter		Afterburner with Heat Recovery		Mist Eliminator	
Facility	Nm^3/s	scfm	Purchased Equipment	Total Capital Investment	Purchased Equipment	Total Capital Investment	Purchased Equipment	Total Capital Investment
Filler Surge & Storage	1.37	2,900	24	31				
Parting Agent Surge & Storage	0.99	2,100	22	28				
Blowing Stills	2.83	6,000			170	213		
Modified Bitumen Mixing	0.94	2,000			83	104		
Asphalt Storage	0.35	750					26	32

(1) All costs include ductwork, control device, fan and stack.

(2) Nm^3/s = Normal cubic meter per second; volume is calculated at 70°F (21°C) and 1 atm. (101.3 kPa).

scfm = standard cubic feet per minute; volume is calculated at 70°F (21°C) and 1 atm. (101.3 kPa).

TABLE 6-5

CAPITAL COST: COOLING SECTIONS

Second Quarter 1987 Dollars

	Cost (thousand $)			
	Evaporative Recirculating(1)		Finned Tube	
Facility	Purchased Equipment	Tot. Cap. Investment	Purchased Equipment	Tot. Cap. Investment
Saturator Wet Looper & Coater	32	62	32	40
Coater Only	24	48	20	26
Modified Bitumen Process-Mixing	14	26	11	14
Modified Bitumen Process-Impregnation	20	39	20	26

(1) Cost includes spray chamber, spray chamber feed and bottoms pumps, a 3-hour hold-up time decanter/recirculation tank and a condensed oil pump.

TABLE 6-6

CAPITAL COST: FULL ENCLOSURE HOODS

Second Quarter 1987 Dollars

Facility	Full Enclosure Hood Total Capital Investment
Saturator, Wet Looper & Coater	29,000(1)
Coater Only (Fiberglass Products) and Modified Bitumen Process Impregnation Vats	14,000(2)

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(1) Cost in Reference 11 was updated using the Chemical Engineering index for fabricated equipment.

(2) Estimated using procedures in References 11 and 12.

ESP's, ME's, A/BWH/R and FF's can be obtained as skid-mounted modular units, including fan, motor, starter, and instruments and controls, prepiped and prewired. For these units, direct and indirect installation charges were estimated at a total of 25 percent of the purchased equipment cost (Reference 5). HVAF installation requires more site work than a typical skid-mounted unit and direct and indirect installation costs were estimated using procedures and factors in References 5 and 14.

The evaporative recirculating precooling systems consisted of a spray chamber, spray chamber feed and bottoms pumps, a 3-hour hold up time decanter/recirculation tank and a condensed oil pump. A vendor quote (Reference 2) was used to cost the spray chambers. Data in Reference 8 and procedures in References 5 and 14 were used to estimate the cost of the remaining items. The recirculating water flow was calculated as shown in Appendix A. The evaporative cooling system for the modified bitumen process impregnation vats costs less than that for the fiberglass mat process coater, although the air flows are the same, because the modified bitumen process temperatures are lower, 356°F versus 470°F for the fiberglass mat. This cost difference is not reflected in the finned tube precooler costs because these are vendors package units (Reference 4) sized to handle a range of gas flows.

A spare filter element set was included in the cost of the ME's to allow repacking of the elements, which is done by the vendor and requires several weeks, without shutting down the plant for that period. Similarly, a spare set of cells was included in the cost of ESP's, where manual cleaning was estimated, to minimize downtime. Where necessary, equipment costs were adjusted to second quarter 1987 using the appropriate Chemical Engineering equipment cost index.

The costs obtained as described above should have study estimate accuracy, about ±30 percent.

6.2.2 Unit Costs

Annual costs are made up of direct operating charges which are the direct costs of operating the equipment, and indirect costs which are fixed and accrue whether the equipment is operating or not. Direct operating costs include operating and maintenance labor, maintenance materials, utilities, supervision and any other charges (e.g., filter media for the HVAF or ME or detergent for ESP's). Indirect charges are overhead, taxes, insurance, administrative charges and capital recovery. Recovered material credits, if any, are included in annual costs under a separate heading. Unit costs and their sources used in this study are listed in Table 6-7. An example of the calculation of annual costs is given in Appendix A. Indexing was not required to update the annual costs since all inputs were current. All annual costs are measured against a baseline of zero control.

Based on Section 114 letter responses, recovered material credits were included only for the mineral baghouse costs. Oil recovered by ESP's, ME's or HVAF's is sometimes sold for credit or is sometimes a disposal cost, depending, apparently, on the location of the roofing plant relative to a potential customer or disposal point. There was no indication it was recycled. Neither cost nor credit was used in this study.

There is little information available on the amount of operating and maintenance labor and maintenance material required for the various control systems or on equipment life. For this study, charges of 0.5 hour per shift of operating and maintenance labor were used for all control devices except fabric filters where 1 hour per shift of operating and maintenance labor were assumed.

Capital recovery is the series of equal annual payments, spread over the economic life of the control system, which return the capital investment plus interest. It is calculated as the product of the Capital Recovery Factor (CRF) and the total capital investment, i.e.:

$$\begin{array}{l}\text{annual capital}\\ \text{recovery payment}\end{array} = (\text{CRF}) \times (\text{Total Capital Investment})$$

The CRF is calculated as:

$$\text{CRF} = \frac{i\,(1+i)^n}{(1+i)^n-1}$$

TABLE 6-7

UNIT COSTS USED FOR ESTIMATING CONTROL SYSTEM ANNUAL COSTS

Annual Cost Item	Unit Cost (Credit)	English Equivalent
Direct Annual Costs		
Operating Labor (1)	\$11.03	
Maintenance Labor (2)	\$12.13	
Electricity (3)	\$0.068/KWH	\$0.068/KWH
Fuel Gas (4)	\$3.65/GJ	\$0.0385/therm (7)
Compressed Air (5)	\$5.65/km^3	\$0.16/1000 scf
Cooling Water (6)	\$66.05/km^3	\$0.25/1000 gal
Indirect Annual Costs		
Overhead (8)	Sixty percent of the sum of operating, supervisory and maintenance labor plus maintenance materials	
Property Taxes (9)	One percent of Total Capital Investment	
Insurance (10)	One percent of Total Capital Investment	
Administration (11)	Two percent of Total Capital Investment	
Capital Recovery (12)	CRF x (Total Capital Investment)	
Recovery Credits		
Filler (13)	(\$13.05/Mg)	(\$11.84/ton)
Parting Agent (14)	(\$143.30/Mg)	(\$130.00/ton)

(1) Reference 15
(2) Computed as 10% over Operating Labor
(3) References 18,21
(4) References 19,21
(5) Reference 5
(6) Reference 20
(7) One therm = 100,000 Btu
(8) Reference 5
(9) Reference 5
(10) Reference 5
(11) Reference 5

(12) $\mathrm{CRF} = \dfrac{i(1+i)^n}{(1+i)^n - 1}$

where i = interest rate - 10% was used in this chapter in accordance with OMB guidelines.

n = control system economic life.

(13) Reference 16
(14) Reference 17

where

i = the interest rate

n = the economic life of the control system.

For this study, the ESP, and HVAF and ME systems were assumed to have an economic life of 20 years. A 10-year life was assumed for the A/BWH/R due to the extreme operating conditions. An interest rate of 10% was used in accordance with OMB guidelines.

The quantity of detergent required to automatically clean the cells on an ESP was estimated at 1.5 gal/(1000 scfm) (week) by the vendor (Reference 22). The cost of detergent so derived was also used as a best estimate for the cost of solvent or detergent for a manual cleaning since no data on the cost of the latter approach was available. Similarly it was assumed either type of cleaning would be covered by the 0.5 hr per shift operating labor since the automatic cleaning requires operator attention and the manual cleaning is a simple unplug and plug in operation. Hence labor charges for the two approaches are equal.

A purge for evaporative recirculating precooling was estimated as equal to the quantity of water evaporated, a rule-of-thumb used for cooling tower operation. The makeup water requirement was then equal to twice the evaporation.

The annual costs obtained using the unit costs described above should be about as accurate as the capital costs, about ±30 percent.

6.3 ANNUAL CONTROL COSTS

Annual control costs for the various proposed control devices are detailed by emission point in Tables 6-8 to 6-18. Comparing the annual costs for the ESP, HVAF, and ME control systems shows that the ESP is consistently lower, largely due to the lower pressure drop which results in a lower electric power requirement. The difference in cost between manual and automatic cleaning of the ESP's is almost insignificant.

The difference in annual cost between evaporative recirculating and finned tube precoolers is small; the lower water cost of evaporative recirculation offsets the higher capital charges. (Compare Tables 6-8, 6-10, 6-15, 6-17 with 6-9, 6-11, 6-16, 6-18).

Table 6-14 illustates why the A/BWH/R is preferred for blowing still pollution abatement. The large amount of entrainment (Table 6-1) in the blowing still off-gas substantially reduces the fuel cost of the A/BWH/R and the credit for asphalt preheating further reduces the cost. When applied to a system with a lower pollutant load such as the Modified Bitumen process mixing tanks (Table 6-15), the A/BWH/R is much more expensive.

6.4 COST EFFECTIVENESS

Cost effectiveness, as calculated for this study, is the annual cost per unit mass of pollutant removed. In this study annual cost is the annual cost of operating the control device and includes direct operating charges such as operating and maintenance labor, maintenance materials and utilities and indirect costs such as overhead, taxes, insurance, administrative charges and capital recovery costs. Recovered material credits, if any, are included and reduce the annual cost. Total annual cost for each of the various control systems is given in Tables 6-8 to 6-18.

The mass of pollutant removed by each control system is given in Table 6-1. All of the values in Table 6-1 are calculated from a baseline of no control.

Cost effectiveness for this study then, was obtained by dividing the total annual cost for a control device by the mass of pollutant removed, e.g., for filler surge and storage operating 4,000 hours per year:

$$\text{Cost Effectiveness} = \frac{\$36{,}900/\text{yr (Table 6-12)}}{29.35 \text{ tons/yr (Table 6-1)}} = 1{,}260 \ \$/\text{ton}$$

This definition of cost effectiveness allows alternative control devices to be compared within an industry.

Cost effectiveness values are given in Tables 6-19, 6-20, and 6-21. All the values are calculated from a baseline of no control.

Examination of the tables shows that for any particular facility, the cost of control is almost independent of the control device used,

TABLE 6-8

ANNUAL COST: SATURATOR, WET LOOPER AND COATER CONTROL SYSTEMS-EVAPORATIVE RECIRCULATING PRECOOLER

Second Quarter 1987 Dollars

	Cost (thousand $)							
	Electrostatic Precipitator							
	Automatic Cleaning		Manual Cleaning		High Velocity Air Filter		Mist Eliminator	
Annual Operating Hours	4000	8000	4000	8000	4000	8000	4000	8000
Direct Annual Costs								
Operating Labor	2.8	5.5	2.8	5.5	2.8	5.5	2.8	5.5
Supervision	0.4	0.8	0.4	0.8	0.4	0.8	0.4	0.8
Maintenance Labor	3.0	6.0	3.0	6.0	3.0	6.0	3.0	6.0
Maintenance Materials	3.0	6.0	3.0	6.0	3.0	6.0	3.0	6.0
Filter Media					2.0	4.0		
Repack Elements							3.9	7.7
Detergents	3.0	6.0	3.0	6.0				
Utilities								
Electricity(1)	6.9	13.8	6.9	13.8	20.4	41.4	12.4	24.7
Cooling Water	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0
Indirect Annual Costs								
Overhead	5.5	11.1	5.5	11.1	5.5	11.1	5.5	11.1
Property Tax	2.0	2.0	2.0	2.0	2.0	2.0	2.4	2.4
Insurance	2.0	2.0	2.0	2.0	2.0	2.0	2.4	2.4
Administration	3.9	3.9	3.8	3.8	4.1	4.1	4.9	4.9
Capital Recovery	23.0	23.0	22.4	22.4	24.0	24.0	28.5	28.5
Total Annual Cost(2)	56.0	81.1	55.1	80.2	70.1	108.0	69.7	101.2

(1) Pressure drops used to estimate electric power costs were 7.8, 34, and 20 inches of water for the Electrostatic Precipitator, High Velocity Air Filter and Mist-Eliminator respectively. Cost of power to drive precooler recirculating pumps is also included.

(2) Columns may not add exactly to total due to rounding.

TABLE 6-9

ANNUAL COST: SATURATOR, WET LOOPER AND COATER CONTROL SYSTEMS-FINNED TUBE PRECOOLER

Second Quarter 1987 Dollars

	Cost (thousand $)							
	Electrostatic Precipitator							
	Automatic Cleaning		Manual Cleaning		High Velocity Air Filter		Mist Eliminator	
Annual Operating Hours	4000	8000	4000	8000	4000	8000	4000	8000
Direct Annual Costs								
Operating Labor	2.8	5.5	2.8	0.5	2.8	5.5	2.8	5.5
Supervision	0.4	0.8	0.4	0.8	0.4	0.8	0.4	0.8
Maintenance Labor	3.0	6.0	3.0	6.0	3.0	6.0	3.0	6.0
Maintenance Materials	3.0	6.0	3.0	6.0	3.0	6.0	3.0	6.0
Filter Media					2.0	4.0		
Repack Elements							3.9	7.7
Detergents	3.0	6.0	3.0	6.0				
Utilities								
Electricity[1]	4.7	9.4	4.7	9.4	18.5	37.0	10.2	20.3
Cooling Water	5.0	10.0	5.0	1.0	5.0	10.0	5.0	10.0
Indirect Annual Costs								
Overhead	5.5	11.1	5.5	11.1	5.5	11.1	5.5	11.1
Property Tax	1.7	1.7	1.7	1.7	1.8	1.8	2.2	2.2
Insurance	1.7	1.7	1.7	1.7	1.8	1.8	2.2	2.2
Administration	3.5	3.5	3.5	3.5	3.5	3.5	4.4	4.4
Capital Recovery	20.4	20.4	20.4	20.4	21.3	21.3	26.0	26.0
Total Annual Cost[2]	54.7	82.2	54.1	81.5	68.7	109.0	68.6	102.4

(1) Pressure drops used to estimate electric power costs were 7.8, 34, and 20 inches of water for the Electrostatic Precipitator, High Velocity Air Filter and Mist Eliminator respectively.

(2) Columns may not add exactly to total due to rounding.

TABLE 6-10

ANNUAL COST: FIBERGLASS MAT COATER CONTROL SYSTEMS-EVAPORATIVE RECIRCULATING PRECOOLER

Second Quarter 1987 Dollars

	Cost (thousand $)							
	Electrostatic Precipitator							
	Automatic Cleaning		Manual Cleaning		High Velocity Air Filter		Mist Eliminator	
Annual Operating Hours	4000	8000	4000	8000	4000	8000	4000	8000
Direct Annual Costs								
Operating Labor	2.8	5.5	2.8	5.5	2.8	5.5	2.8	5.5
Supervision	0.4	0.8	0.4	0.8	0.4	0.8	0.4	0.8
Maintenance Labor	3.0	6.0	3.0	6.0	3.0	6.0	3.0	6.1
Maintenance Materials	3.0	6.0	3.0	6.0	3.0	6.0	3.0	6.1
Filter Media					0.2	0.4		
Repack Elements							0.2	0.4
Detergents	1.7	3.4	1.7	3.4				
Utilities								
Electricity	3.9	7.8	3.9	7.8	11.9	23.7	8.4	16.7
Cooling Water	0.3	0.6	0.3	0.6	0.3	0.6	0.3	0.6
Indirect Annual Costs								
Overhead	5.5	11.1	5.5	11.1	5.5	11.1	5.5	11.1
Property Tax	1.5	1.5	1.5	1.5	1.5	1.5	1.8	1.8
Insurance	1.5	1.5	1.5	1.5	1.5	1.5	1.8	1.8
Administration	3.1	3.1	2.9	2.9	3.1	3.1	3.7	3.7
Capital Recovery	18.0	18.0	17.3	17.3	18.1	18.1	18.0	18.0
Total Annual Cost*	44.7	65.3	43.8	64.4	51.4	78.3	49.0	72.6

*Columns may not add exactly to total due to rounding.

TABLE 6-11

ANNUAL COST: FIBERGLASS MAT COATER CONTROL SYSTEMS-FINNED TUBE PRECOOLER

Second Quarter 1987 Dollars

	Cost (thousand $)							
	Electrostatic Precipitator							
	Automatic Cleaning		Manual Cleaning		High Velocity Air Filter		Mist Eliminator	
Annual Operating Hours	4000	8000	4000	8000	4000	8000	4000	8000
Direct Annual Costs								
Operating Labor	2.8	5.5	2.8	5.5	2.8	5.5	2.8	5.5
Supervision	0.4	0.8	0.4	0.8	0.4	0.8	0.4	0.8
Maintenance Labor	3.0	6.0	3.0	6.0	3.0	6.0	3.0	6.0
Maintenance Materials	3.0	6.0	3.0	6.0	3.0	6.0	3.0	6.0
Filter Media					0.2	0.4		
Repack Elements							0.2	0.4
Detergents	1.7	3.4	1.7	3.4				
Utilities								
Electricity	2.6	5.3	2.6	5.3	10.6	21.2	7.1	14.2
Cooling Water	2.9	5.7	2.9	5.7	2.9	5.7	2.9	5.7
Indirect Annual Costs								
Overhead	5.5	11.1	5.5	11.1	5.5	11.1	5.5	11.1
Property Tax	1.3	1.3	1.3	1.3	1.3	1.3	1.6	1.6
Insurance	1.3	1.3	1.3	1.3	1.3	1.3	1.6	1.6
Administration	2.6	2.6	2.5	2.5	2.6	2.6	3.2	3.2
Capital Recovery	15.4	15.4	14.7	14.7	15.5	15.5	19.0	19.0
Total Annual Cost*	42.5	64.4	41.7	63.6	49.2	77.7	50.3	75.3

*Columns may not add exactly to total due to rounding.

TABLE 6-12

ANNUAL COST: MINERAL SURGE AND STORAGE CONTROL SYSTEM

Second Quarter 1987 Dollars

	Fabric Filters Cost (thousand $)			
	Filler Surge and Storage		Parting Agent Surge and Storage	
Annual Operating Hours	4000	8000	4000	8000
Direct Annual Costs				
Operating Labor	5.5	11.0	5.5	11.0
Supervision	0.8	1.7	0.8	1.7
Maintenance Labor	6.0	12.1	6.0	12.1
Maintenance Material	6.0	12.1	6.0	12.1
Replacement Bags	0.9	1.8	0.7	1.4
Utilities				
Electricity	1.8	3.5	1.3	2.5
Compressed Air	0.2	0.5	0.2	0.3
Indirect Annual Costs				
Overhead	11.1	22.2	11.1	22.0
Property Tax	0.3	0.3	0.3	0.3
Insurance	0.3	0.3	0.3	0.3
Administration	0.6	0.6	0.6	0.6
Capital Recovery	3.6	3.6	3.3	3.3
Recovery Credits				
Mineral	(0.4)	(0.7)	(2.8)	(5.5)
Total Annual Cost*	36.9	69.0	33.3	62.2

*Columns may not add exactly to total due to rounding.

TABLE 6-13

ANNUAL COST: ASPHALT STORAGE CONTROL SYSTEM

Second Quarter 1987 Dollars

	Mist Eliminator Cost (thousand $)	
Annual Operating Hours	800	4800
Direct Annual Costs		
Operating Labor	0.3	1.7
Supervision	-	0.2
Maintenance Labor	0.3	1.8
Maintenance Material	0.3	1.8
Repack Elements	0.1	0.2
Utilities		
Electricity	0.3	1.8
Indirect Annual Costs		
Overhead	0.6	3.3
Property Tax	0.3	0.3
Insurance	0.3	0.3
Administration	0.6	0.6
Capital Recovery	3.7	3.7
Total Annual Costs*	6.9	15.9

*Columns may not add exactly to total due to rounding.

TABLE 6-14

ANNUAL COST: BLOWING STILL CONTROL SYSTEM

Second Quarter 1987 Dollars

	After Burner with Heat Recovery Cost (thousand $)
	2000 Annual Operating Hours
Direct Annual Costs	
Operating Labor	1.4
Supervision	0.2
Maintenance Labor	1.5
Maintenance Material	1.5
Utilities	
Electricity	2.9
Fuel (Nat. Gas)	5.8
Indirect Annual Costs	
Overhead	2.8
Property Tax	2.1
Insurance	2.1
Administration	4.2
Capital Recovery	34.6
Recovery Credits	
Fuel (Nat. Gas)	(48.0)
Total Annual Cost*	11.2

*Columns may not add exactly to total due to rounding.

TABLE 6-15

ANNUAL COST: MODIFIED BITUMEN PROCESS, MIXING, CONTROL SYSTEMS-EVAPORATIVE RECIRCULATING PRECOOLER

Second Quarter 1987 Dollars

	Costs (thousand $)									
	Electrostatic Precipitator									
	Automatic Cleaning		Manual Cleaning		High Velocity Air Filter		Mist Eliminator		After Burner With Heat Recovery**	
Annual Operating Hours	5000	8000	5000	8000	5000	8000	5000	8000	5000	8000
Direct Annual Costs										
Operating Labor	3.4	5.5	3.4	5.5	3.4	5.5	3.4	5.5	3.4	5.5
Supervision	0.5	0.8	0.5	0.8	0.5	0.8	0.5	0.8	0.5	0.8
Maintenance Labor	3.8	6.0	3.8	6.0	3.8	6.0	3.8	6.0	3.8	6.1
Maintenance Material	3.8	6.0	3.8	6.0	3.8	6.0	3.8	6.0	3.8	6.1
Detergents	0.7	1.1	0.7	1.1						
Filter Media					0.5	0.7				
Repack Elements							0.3	0.5		
Utilities										
Electricity	1.4	2.3	1.4	2.3	4.5	7.2	4.1	6.6	3.0	4.7
Fuel (Nat. Gas)									48.1	77.0
Cooling Water	0.1	0.2	2.8	4.5	0.1	0.2	0.1	0.2		
Indirect Annual Costs										
Overhead	6.9	11.1	6.9	11.1	6.9	11.1	6.9	11.1	6.9	11.1
Property Tax	0.6	0.6	0.6	0.6	0.9	0.9	0.9	0.9	1.0	1.0
Insurance	0.6	0.6	0.6	0.6	0.9	0.9	0.9	0.9	1.0	1.0
Administration	1.2	1.2	1.2	1.2	1.7	1.7	1.9	1.9	2.1	2.1
Capital Recovery	7.2	7.2	6.9	6.9	10.0	10.0	11.0	11.0	16.9	16.9
Recovery Credits										
Fuel (Nat. Gas)									(37.7)	(60.2)
Total Annual Cost*	30.2	42.6	29.9	42.3	36.9	51.1	37.8	51.6	52.3	72.1

*Columns may not add exactly to total due to rounding.
**Afterburner does not have precooler.

TABLE 6-16

ANNUAL COST: MODIFIED BITUMEN PROCESS, MIXING, CONTROL SYSTEMS-FINNED TUBE PRECOOLER

Second Quarter 1987 Dollars

	Costs (thousands $)									
	Electrostatic Precipitator									
	Automatic Cleaning		Manual Cleaning		High Velocity Air Filter		Mist Eliminator		After Burner With Heat Recovery**	
Annual Operating Hours	5000	8000	5000	8000	5000	8000	5000	8000	5000	8000
Direct Annual Costs										
Operating Labor	3.4	5.5	3.4	5.5	3.4	5.5	3.4	5.5	3.4	5.5
Supervision	0.5	0.8	0.5	0.8	0.5	0.8	0.5	0.8	0.5	0.8
Maintenance Labor	3.8	6.0	3.8	6.0	3.8	6.0	3.8	6.1	3.8	6.1
Maintenance Material	3.8	6.0	3.8	6.0	3.8	6.0	3.8	6.1	3.8	6.1
Detergents	0.7	1.1	0.7	1.1						
Filter Media					0.5	0.7				
Repack Elements							0.3	0.5		
Utilities										
Electricity	1.1	1.8	1.1	1.8	4.2	6.7	3.8	6.1	3.0	4.7
Fuel (Nat. Gas)									48.1	77.0
Cooling Water	0.8	1.3	0.8	1.3	0.8	1.3	0.8	1.3		
Indirect Annual Costs										
Overhead	6.9	11.1	6.9	11.1	6.9	11.1	6.9	11.1	6.9	11.1
Property Tax	0.5	0.5	0.5	0.5	0.7	0.7	0.8	0.8	1.0	1.0
Insurance	0.5	0.5	0.5	0.5	0.7	0.7	0.8	0.8	1.0	1.0
Administration	1.0	1.0	0.9	0.9	1.5	1.5	1.6	1.6	2.1	2.1
Capital Recovery	5.8	5.8	5.5	5.5	8.6	8.6	9.6	9.6	16.9	16.9
Recovery Credits										
Fuel (Nat. Gas)									(37.7)	(60.2)
Total Annual Cost*	28.8	41.4	28.4	41.0	35.5	49.8	36.3	50.4	52.3	72.1

*Columns may not add exactly to total due to rounding.
**Afterburner does not have precooler.

TABLE 6-17

ANNUAL COST: MODIFIED BITUMEN PROCESS, IMPREGNATION VATS, CONTROL SYSTEMS-EVAPORATIVE RECIRCULATING PRECOOLER

Second Quarter 1987 Dollars

	Cost (thousand $)							
	Electrostatic Precipitator Automatic Cleaning		Electrostatic Precipitator Manual Cleaning		High Velocity Air Filter		Mist Eliminator	
Annual Operating Hours	5000	8000	5000	8000	5000	8000	5000	8000
Direct Annual Costs								
Operating Labor	3.4	5.5	3.4	5.5	3.4	5.5	3.4	5.5
Supervision	0.5	0.8	0.5	0.8	0.5	0.8	0.5	0.8
Maintenance Labor	3.8	6.0	3.8	6.0	3.8	6.0	3.8	6.0
Maintenance Material	3.8	6.0	3.8	6.0	3.8	6.0	3.8	6.0
Detergent	2.1	3.4	2.1	3.4				
Filter Media					0.1	0.1		
Repack Elements							0.1	0.1
Utilities								
Electricity	4.2	6.7	4.2	6.7	14.2	22.6	7.3	11.6
Cooling Water	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2
Indirect Annual Costs								
Overhead	6.9	11.1	6.9	11.1	6.9	11.1	6.9	11.1
Property Tax	1.4	1.4	1.3	1.3	1.5	1.5	1.8	1.8
Insurance	1.4	1.4	1.3	1.3	1.5	1.5	1.8	1.8
Administration	2.7	2.7	2.6	2.6	2.9	2.9	3.5	3.5
Capital Recovery	15.9	15.9	15.2	15.2	17.0	17.0	20.6	20.6
Total Annual Cost*	46.2	61.1	45.2	60.1	55.7	75.4	53.5	69.0

*Columns may not add exactly to total due to rounding.

TABLE 6-18

ANNUAL COST: MODIFIED BITUMEN PROCESS, IMPREGNATION VATS, CONTROL SYSTEMS-FINNED TUBE PRECOOLER

Second Quarter 1987 Dollars

	Cost (thousand $)							
	Electrostatic Precipitator							
	Automatic Cleaning		Manual Cleaning		High Velocity Air Filter		Mist Eliminator	
Annual Operating Hours	5000	8000	5000	8000	5000	8000	5000	8000
Direct Annual Costs								
Operating Labor	3.4	5.5	3.4	5.5	3.4	5.5	3.4	5.5
Supervision	0.5	0.8	0.5	0.8	0.5	0.8	0.5	0.8
Maintenance Labor	3.8	6.0	3.8	6.0	3.8	6.0	3.8	6.0
Maintenance Material	3.8	6.0	3.8	6.0	3.8	6.0	3.8	6.0
Detergent	2.1	3.4	2.1	3.4				
Filter Media					0.1	0.1		
Repack Elements							0.1	0.1
Utilities								
Electricity	3.3	5.3	3.3	5.3	13.3	21.2	6.4	10.2
Cooling Water	2.5	4.0	2.5	4.0	2.5	4.0	2.5	4.0
Indirect Annual Costs								
Overhead	6.9	11.1	6.9	11.1	6.9	11.1	6.9	11.1
Property Tax	1.2	1.2	1.2	1.2	1.3	1.3	1.6	1.6
Insurance	1.2	1.2	1.2	1.2	1.3	1.3	1.6	1.6
Administration	2.4	2.4	2.3	2.3	2.6	2.6	3.2	3.2
Capital Recovery	14.3	14.3	13.6	13.6	15.5	15.5	19.0	19.0
Total Annual Cost*	45.3	61.2	44.6	60.4	55.1	75.7	52.9	69.3

*Columns may not add exactly to total due to rounding.

TABLE 6-19

COST EFFECTIVENESS: ELECTROSTATIC PRECIPITATOR, HIGH VELOCITY AIR FILTER AND MIST ELIMINATOR CONTROL SYSTEMS EVAPORATIVE RECIRCULATING PRECOOLER

Second Quarter 1987 Dollars

		Pollution Control Cost Effectiveness(1)							
		Electrostatic Precipitator							
		Automatic Cleaning		Manual Cleaning		High Velocity Air Filter		Mist Eliminator	
Facility	Annual Operating Hours	$/Mg	$/Ton	$/Mg	$/Ton	$/Mg	$/Ton	$/Mg	$/Ton
Saturator Wet Looper & Coater	4000	911	826	896	813	1,140	1,030	1,090	989
	8000	659	598	652	592	878	797	792	718
Fiberglass Mat Coater	4000	9,590	8,713	9,400	8,540	11,000	10,000	10,100	9,180
	8000	7,010	6,370	6,910	6,280	8,400	7,630	7,500	6,800
Modified Bitumen Mixing	5000	3,090	2,810	3,060	2,780	3,780	3,430	3,720	3,380
	8000	2,730	2,480	2,710	2,460	3,274	2,970	3,180	2,884
Modified Bitumen Impregnation	5000	59,000	53,500	57,700	52,400	71,100	64,500	65,700	59,600
	8000	48,900	44,300	48,100	43,600	60,300	54,600	53,100	47,900

(1) All values are calculated from a baseline of no control.

TABLE 6-20

COST EFFECTIVENESS: ELECTROSTATIC PRECIPITATOR, HIGH VELOCITY AIR FILTER AND MIST ELIMINATOR CONTROL SYSTEMS
FINNED TUBE PRECOOLER

Second Quarter 1987 Dollars

Facility	Annual Operating Hours	Pollution Control Cost Effectiveness(1)							
		Electrostatic Precipitator				High Velocity Air Filter		Mist Eliminator	
		Automatic Cleaning		Manual Cleaning					
		$/Mg	$/Ton	$/Mg	$/Ton	$/Mg	$/Ton	$/Mg	$/Ton
Saturator Wet Looper & Coater	4000	890	810	880	800	1,120	1,010	1,070	970
	8000	670	610	660	600	890	800	800	730
Fiberglass Mat Coater	4000	9,120	8,290	8,950	8,130	10,600	9,600	10,400	9,420
	8000	6,910	6,277	6,820	6,200	9,130	8,290	7,780	7,050
Modified Bitumen Mixing	5000	3,950	2,680	2,910	2,640	3,640	3,300	3,580	3,240
	8000	2,650	2,410	2,630	2,380	3,190	2,890	3,110	2,820
Modified Bitumen Impregnation	5000	58,000	52,600	57,000	51,700	70,400	63,800	65,000	59,000
	8000	49,000	44,300	48,300	43,800	60,600	54,900	53,300	48,100

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(1) All values are calculated from a baseline of no control.

TABLE 6-21

COST EFFECTIVENESS: FABRIC FILTER, AFTERBURNER WITH HEAT RECOVERY AND ASPHALT STORAGE MIST ELIMINATOR CONTROL SYSTEMS

Second Quarter 1987 Dollars

		Pollution Control Cost Effectiveness[1]					
		Mist Eliminator		Fabric Filter		After Burner With Heat Recovery	
Facility	Annual Operating Hours	$/Mg	$/Ton	$/Mg	$/Ton	$/Mg	$/Ton
Filler Surge & Storage	4000			1,390	1,260		
	8000			1,300	1,180		
Parting Agent Surge & Storage	4000			1,730	1,570		
	8000			1,610	1,460		
Asphalt Storage	800	4,760	4,310				
	4800	1,823	1,656				
Blowing Stills	2000					32	29
Modified Bitumen Mixing						5,100	4,630
						4,400	3,990

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[1] All values are calculated from a baseline of no control.

with one exception. The A/BWH/R on the Modified Bitumen Process Mixing tanks costs about twice as much per unit weight of pollutant collected as the alternative devices, due to the low pollutant load and the consequent high fuel cost. With this exception, the differences in cost effectiveness between devices for the same source are within the error in the cost numbers and have little significance.

The data also illustrate why the A/BWH/R is exclusively chosen for blowing stills. The high pollutant load results in a low fuel cost which translates to a cost effectiveness better by an order of magnitude than values for possible alternative systems such as an ESP or ME.

6.5 REFERENCES FOR CHAPTER 6

1. Asphalt Roofing Manufacturing Industry - Background Information for Proposed Standards, EPA 450/3-80-021A, U.S. Environmental Protection Agency, Research Triangle Park, NC, June 1980.
2. Dwayne L. Sanders (Anderson 2000, Peachtree City, GA) to R.R. Ellefson (JACA Corp., Fort Washington, PA), Letter, June 23, 1987.
3. S.A. Sauerland (United Air Specialists, Cincinnati, OH) to R.R. Ellefson (JACA Corp., Fort Washington, PA), Letter, June 15, 1987.
4. Colin N. Dougald (Monsanto Enviro-Chem, St. Louis, MO) to R.R. Ellefson (JACA Corp., Fort Washington, PA), Letter, June 11, 1987.
5. EAB Cost Control Manual, Third Edition, EPA 450/5-87-001A, U.S. Environmental Protection Agency, Research Triangle Park, NC, February 1987.
6. William M. Vatavuk and Robert B. Neveril, "Estimating Costs of Air-Pollution Control Systems, Part XI: Estimate the Size and Cost of Baghouses," Chemical Engineering, March 22, 1982, p. 153.
7. Edward D. Burns, Jr. (John Zink Co., Tulsa, OK) to R.R. Ellefson (JACA Corp., Fort Washington, PA), Letter, Fume Incinerator, John Zink P706-124NE," June 17, 1987.
8. Richard S. Hall et al, "Current Costs of Process Equipment," Chemical Engineering, April 5, 1982, p. 80.
9. William M. Vatavuk and Robert B. Neveril, "Estimating Costs of Air-Pollution Control Systems," Part IV: Estimating the Size and Cost of Ductwork," Chemical Engineering, December 29, 1980, p. 71.
10. Lewis Warren (Philadelphia Air Products, Philadelphia, PA with R.R. Ellefson (JACA Corp., Fort Washington, PA), Telecon, August 26, 1987.
11. Pat Shea (Midwest Research Institute) to Dianne M. Byrne (Midwest Research Institute), Memo, January 28, 1982.

12. William M. Vatavuk and Robert B. Neveril, "Estimating Costs of Air-Pollution Control Systems, Part III: Estimating the Size and Cost of Pollutant Capture Hoods," Chemical Engineering, December 1, 1980, p. 111.
13. William M. Vatavuk and Robert B. Neveril, "Estimating Costs of Air-Pollution Control Systems," Part VII: Estimating Costs of Fans and Accessories," Chemical Engineering, May 18, 1981, p. 171.
14. William M. Vatavuk and Robert B. Neveril, "Estimating Costs of Air-Pollution Control Systems," Part II: Factors for Estimating Capital and Operating Costs," Chemical Engineering, November 3, 1980, p. 157.
15. Employment and Earnings, U.S. Department of Labor, Bureau of Statistics, Table C-2, Paving and Roofing Materials, SIC 295, March 1987.
16. Barbara Reilly (Thomasville Stone & Lime - Thomasville, PA) with R.R. Ellefson (JACA Corp., Fort Washington, PA), Telecon, May 26, 1987.
17. Ken Valeri (Whittaker, Clark & Daniels, South Plainfield, NJ) with R.R. Ellefson (JACA Corp., Fort Washington, PA), Telecon, May 26, 1987.
18. Jack Rowley (Philadelphia Electric, Philadelphia, PA), with R.R. Ellefson (JACA Corp., Fort Washington, PA), Telecon, May 22, 1987.
19. Bill Delcross (Philadelphia Gas Works, Philadelphia, PA) with R.R. Ellefson (JACA Corp., Fort Washington, PA), Telecon, May 22, 1987.
20. William M. Vatavuk (U.S. Environmental Protection Agency, Research Triangle Park, NC) with R.R. Ellefson (JACA Corp., Fort Washington, PA), Telecon, July 24, 1987.
21. CPI Detailed Report - Data for January 1987, U.S. Department of Labor - Bureau of Labor Statistics, Table P2.

22. S. A. Sauerland (United Air Specialists, Cincinnati, OH) with R.R. Ellefson (JACA Corp., Fort Washington, PA), Telecon, June 22, 1987.

23. Robert H. Perry, ed., Perry's Chemical Engineers Handbook, 6th ed. (New York: McGraw Hill, 1984) Section 12, Figure 12-3.

APPENDIX A

LINE ITEM ANNUAL COST EXAMPLE
SATURATOR, WET LOOPER AND COATER
ELECTROSTATIC PRECIPITATOR
AUTOMATIC CLEANING-FINNED TUBE PRECOOLER

Direct Costs

Operating Labor at 0.5 hr/shift	
$\frac{8000}{8} \times 0.5 \times 11.03$	5,515
Supervision at 15% of Operating Labor	
0.15×5515	827
Maintenance Labor at 0.5 hr/shift	
$\frac{8000}{8} \times 0.5 \times 11.03 \times 1.1$	6,067
Maintenance Material at 100% of Maintenance Labor	6,067
Detergent for Weekly Cleaning	
Vendors recommendation(1)	5,971
Utilities (2)	
Electricity $17.0\ \text{KW} \times 8000\ \text{hr} \times 0.068\ \frac{\$}{\text{KW hr}}$	9,250
Cooling Water $83.5\ \frac{\text{gal}}{\text{min}} \times 60 \times 8000$	
$\times\ \$0.25/1000$ gal	10,020
TOTAL DIRECT COST	43,717

Indirect Costs

Overhead at 60% of sum of total Labor and Maintenance Materials 0.6 (5515 + 827 + 6067 + 6067)	11,085
Property Tax at 1% of Total Capital Investment = 0.01 (174,000)	1,740
Insurance at 1% of Total Capital Investment = 0.01 (174,000)	1,740
Administration at 2% of Total Capital Investment = 0.02 (174,000)	3,480
Capital Recovery, 20-year life and 10% interest = $\left[\frac{0.1(1.1)^{20}}{(1.1)^{20}-1}\right]$ x (174,000)	20,445
Total Indirect Cost	38,490
TOTAL ANNUAL COST	82,207
Say	82,200

Notes:

(1) Vendors recommendation (Reference 21) is 1.5 gal of detergent per 1000 scfm per week. Detergent cost is $8/gal, so cost is:

$$10{,}450 \times 0.001 \times \frac{8000}{168} \times 1.5 \times 8 = \$5971/\text{year}$$

(2) Utility Requirements

Cooling water requirement: Waste gas must be cooled from 470°F to 100°F.

A. Finned Tube Precooler

Convert gas flow to lbs/min. Use ideal gas law with $R = 0.7302\ (\text{atm})\ (\text{ft}^3)/\text{lbmole})(°\text{F})$

$$(1)(10{,}450) = \left(\frac{\text{lbs.gas}}{29}\right)(0.7302)(530)$$

$$\text{lbs.gas} = 783\ \text{lbs/min}$$

Heat capacity = 0.24 Btu(lb)(°F) (Reference 23 Figure 3-12)

Sensible heat to cool gas = (0.24)x(783)x(470-100) = 69536 Btu/min

$$\text{Pollutant load} = \frac{135.68 \times 2000}{8000 \times 60} = 0.5649\ \text{lbs/min}$$

One-half condensed = 0.28 lbs/min

Latent heat = 0.28 (150) = 42.4 Btu/min

Total heat released = 42 + 69536 = 69578 Btu/min

Use 100°F rise for water

$$\text{lbs/hr water} = \frac{69578}{(100)(1.0)} = 695.8\ \text{lbs/min}$$

$$= 83.5\ \text{gal/min}$$

B. Evaporative Recirculating Precooler

Spray chamber is in counter current flow. It is assumed gas entering spray chamber is at 470°F and dry. The psychometric chart (Reference 23) shows that dry gas at 470°F will reach saturation at 121.8°F. Water content at saturation is 0.0862 lbs/lb dry gas.

At saturation remainder of cooling is by direct heat transfer against the incoming water. As the gas cools some of the water it contains will condense (Reference 23). The water content of saturated gas at 100°F is 0.0429 lbs/lb dry gas. Therefore:

Sensible heat of cooling = 783(0.24)(121.8-100) = 4,097 Btu/min

Heat of condensation = 783(0.0862-0.0429)(1043) = 35,364 Btu/min

TOTAL 39,461

where 1043 Btu/lb is the latent heat of water.

Quantity of incoming 80°F water required to cool the gas to 100°F = Q:

39461 = Q(1.0) (121.8-80)
Q = 944 lbs/min
= 113 gpm

Quantity of water evaporated = 783(0.0429) = 33.6 lbs/min

Set purge equal to evaporation so makeup = 67.2 lbs/min.
= 8 gpm.

Electricity requirement: Duct and hood pressure drop was estimated at 7 in H_2O. From Reference 22, pressure drop for ESP is about 0.8 in H_2O for a total pressure drop (ΔP) of 7.8 in H_2O.

Equation 5-15 Reference 5

Fan Power = $0.000181(Q)(\Delta P)\phi$

Q = system flow rate acfm
ΔP = pressure drop, in H_2O
ϕ = operating hours

$$Q = 10{,}450 \frac{560}{530} = 11{,}042 \text{ acfm @ } 100°\text{F}$$

Fan power = 0.000181(11,042)7.8 = 15.59 kWh/h
Power to operate ESP = 0.125 kW/1000 acfm (Reference 22)

$$\text{Power requirement} = 0.125(11{,}042)\left(\frac{1}{1000}\right)$$

= 1.38kWh/h

Total Power requirement = 15.59 + 1.38 = 16.97 ~ 17.0 kwh/h

7.0 ENFORCEMENT ASPECTS

According to representatives of the Asphalt Roofing Manufacturers Association (ARMA), there have been no major, widespread problems within the industry in meeting the NSPS requirements.[1]

Complete compliance information and data were often difficult to obtain. The representatives of the regulatory agencies were at times unfamiliar with the NSPS and its requirements.

7.1 EMISSION TESTING

During a meeting with ARMA representatives, several concerns were expressed dealing with emissions testing at asphalt processing and asphalt roofing plants. The first dealt with the length of testing; with the variable production problems associated with organic products, it often takes 2 to 3 days to achieve three 2-hour test runs. During the original NSPS development, it was determined that a 2-hour test run was necessary to achieve sufficient sample weight. Another concern was that testing has become quite costly; $5,000 to $10,000 to test a roofing line, and $10,000 to $20,000 to test a blowing still. In contrast, current EPA estimates for roofing line testing costs are $5,000 to $7,000, and $6,000 to $8,000 for testing a blowing still.[2] In reference to the Method itself, several concerns were also expressed: it is often difficult to maintain the proper probe temperature when testing a blowing still; use of a temperature monitor behind the filter often causes leakage; and there should be safety precautions for the use of the solvent trichloroethane (TCE) specified in the Method, or an alternative solvent recommended.[1] The EPA recognized the difficulties in maintaining proper probe temperature during testing of asphalt blowing stills for the development of the original NSPS. However, it is essential to the Method that proper probe temperature be maintained so that some gaseous phase hydrocarbons do not pass through the filter uncondensed, thus giving incorrect test results. For the same reason, monitoring the temperature of the gas stream behind the filter is crucial to the performance of the Method. Proper probe temperature can be achieved, most likely with a water cooled probe; and with proper assembly and care, leaks can be avoided. During test Method development, it was determined that a chlorinated solvent was necessary to properly clean the equipment; TCE was the least volatile of those appropriate for this application. At this time, no equivalent alternative solvent has been identified. Occupational standards and guidelines for TCE have been published by the Occupational Health and Safety Administration (OSHA).

During a visit by the EPA to an asphalt roofing plant, some additional concerns dealing with testing were presented. The low, variable stack flow rates and corresponding low sample volume (in this instance for a mist eliminator controlling a saturator) made it hard to select the proper nozzle size with which to maintain isokinetic flow.[3] The EPA recognizes that this can be a problem, especially with improperly sized stacks. Individual cases may be reviewed with regulatory agencies if necessary. The need for a minimum filter temperature was questioned; lowering the temperature would potentially condense and collect more particulate matter, thus increasing the emissions for that facility.[3] Due to the fact that this Method is so temperature dependent, the temperature range in which the data was collected to develop the original standard is also the range specified for testing. This will ensure that no plant is unnecessarily determined as out of compliance.

One modified bitumen production facility experienced difficulties with cyclonic flow while testing their impregnation vats (which are uncontrolled). Straightening vanes were installed, and the problem corrected.[4] An asphalt roofing plant encountered problems while testing their new blowing still (controlled by an incinerator); steam is used for fire/explosion prevention, resulting in a high moisture content stack gas. Since the filter temperature is below the dew point, condensation was causing blinding of the filter. The state regulatory agency and the EPA together developed a modified test method to alleviate the difficulties.[5]

There were two instances of use of an improper test method. In these cases, testing was performed using EPA Reference Method 5, which is the standard particulate sampling procedure, rather than EPA Reference Method 5A, which is specifically for asphalt particulate emissions. Method 5A has a lower filter temperature than Method 5, to ensure gas-phase hydrocarbons are condensed, and subsequently captured. The solvent used in Method 5A (trichloroethane) also differs from that in Method 5 (acetone).

Several of the test reports acquired during this review did not contain the required Method 22 fugitive visible emissions data from saturator enclosures, or the Method 9 stack gas opacity data. Monitoring data for the control device operating temperature taken during the performance test was also often not included with the test report as required. However, the required continuous monitoring of these temperatures is being carried out by the majority of the facilities surveyed. Compliance data was available for only one plant that had an affected facility with an opacity standard only (mineral storage and handling, asphalt storage).

7.2 NSPS INTERPRETATION

There are two basic issues in the area of NSPS interpretation: applicability of the standard to the production of fiberglass products (coater only), and applicability of the standard to modified bitumen production.

The standard currently being applied to coaters producing fiberglass products was originally developed for an organic shingle line comprising a saturator, wet looper, and coater combination. The regulatory agencies have taken the limit developed for the organic line and enforced the same limit for a fiberglass line which uses only the coater section. Therefore, it is a lenient limit when applied to the coater only. This limit appears to be uniformly enforced, but there is some question as to whether or not it is an appropriate value. The emissions from fiberglass lines as reported in Chapter 5 are approximately an order of magnitude lower than the NSPS limit being applied.

The production of modified bitumen is a new sector of the asphalt roofing industry which has developed since the original NSPS. Because of this, there are uncertainties in interpretation and inconsistencies in enforcement of the NSPS among the regulatory agencies when applying it to this process. There are 20 plants currently able to produce modified bitumen in the U.S.; only three of these have been determined as subject to the regulation. At all three, the standard which was applied was that for a saturator producing smooth surfaced roll roofing (0.4 kg particulate/Mg roofing produced). However, at one plant the impregnation vats only are being classified as a saturator, while at the other two plants, the impregnation vats and mixing tanks combined are classified as the saturator. There is some question as to whether or not the standard, as currently written, actually applies to this process. The emissions reported are approximately an order of magnitude below the applied limit. The process and product parameters (temperatures, line speeds, product weights) at facilities tested to establish the original NSPS emission limits are substantially different from those at facilities producing modified bitumen. The current standard was developed for lines where asphalt was being applied to organic cellulose fiber felt. In contrast, modified bitumen is an asphalt/polymer mixture which is applied to a polyester web.

7.3 REFERENCES

1. Memorandum from Michelitsch, D.M., EPA: ISB, to Durkee, K.R., EPA: ISB. March 12, 1987. Report on January 15, 1987, meeting with representatives of the Asphalt Roofing Manufacturers Association. 4 pages.

2. Memorandum from Westlin, P.R., EPA: EMB, to Michelitsch, D.M., EPA: ISB. October 29, 1987. Cost Estimates for Asphalt Roofing Manufacturing Emission Tests. 1 page.

3. Memorandum from Michelitsch, D.M., EPA: ISB, to Durkee, K.R., EPA: ISB. February 3, 1987. Report on November 19, 1986, trip to Georgia-Pacific Corporation in Hampton, Georgia. 5 pages.

4. Memorandum from Michelitsch, D.M., EPA: ISB, to Durkee, K.R., EPA: ISB. May 5, 1987. Report on March 1987, trip to U.S. Intec, Inc., North Branch, New Jersey. 6 pages.

5. Telecon. Schmidt, E.J., Georgia-Pacific Corporation, to Michelitsch, D.M., EPA. September 18, 1987. Experiences in testing a blowing still.

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