11.2 Asphalt Roofing

11.2.1 General[1-2]

The asphalt roofing industry manufactures asphalt-saturated felt rolls, fiberglass and organic (felt-based) shingles, and surfaced and smooth roll roofing. Most of these products are used in roof construction, but small quantities are used in walls and other building applications.

11.2.2 Process Description[1-4]

The production of asphalt roofing products consists of six major operations: (1) felt saturation, (2) coating, (3) mineral surfacing (top and bottom), (4) cooling and drying, (5) product finishing (seal-down strip application, cutting and trimming, and laminating of laminated shingles), and (6) packaging. There are six major production support operations: (1) asphalt storage, (2) asphalt blowing, (3) back surfacing and granule storage, (4) filler storage, (5) filler heating, and (6) filler and coating asphalt mixing. There are two primary roofing substrates: organic (paper felt) and fiberglass. Production of roofing products from the two substrates differ mainly in the elimination of the saturation process when using fiberglass.

Preparation of the asphalt is an integral part of the production of asphalt roofing. This preparation, called "blowing," involves the oxidation of asphalt flux by bubbling air through liquid asphalt flux at 260°C (500°F) for 1 to 10 hours. The amount of time depends on the desired characteristics of the roofing asphalt, such as softening point and penetration rate. Blowing results in an exothermic reaction that requires cooling. Water sprays are applied either internally or externally to the shell of the blowing vessel. A typical plant blows four to six batches per 24-hour day. Blowing may be done in either vertical vessels or in horizontal chambers (both are frequently referred to as "blowing stills"). Inorganic salts such as ferric chloride ($FeCl_3$) may be used as catalysts to achieve desired properties and to increase the rate of reaction in the blowing still, decreasing the time required for each blow. Blowing operations may be located at oil refineries, asphalt processing plants, or asphalt roofing plants. Figure 11.2-1 illustrates an asphalt blowing operation.

The most basic asphalt roofing product is asphalt-saturated felt. Figure 11.2-2 shows a typical line for the manufacture of asphalt-saturated felt. It consists of a dry felt feed roll, a dry looper section, a saturator spray section (seldom used today), a saturator dipping section, heated drying-in drums, a wet looper, cooling drums, a finish floating looper, and a roll winder.

Organic felt may weigh from approximately 20 to 55 pounds (lb) per 480 square feet (ft^2) (a common unit in the paper industry), depending upon the intended product. The felt is unrolled from the unwind stand onto the dry looper, which maintains a constant tension on the material. From the dry looper, the felt may pass into the spray section of the saturator (not used in all plants), where asphalt at 205 to 250°C (400 to 480°F) is sprayed onto one side of the felt through several nozzles. In the saturator dip section, the saturated felt is drawn over a series of rollers, with the bottom rollers submerged in hot asphalt at 205 to 250°C (400 to 480°F). During the next step, heated drying-in drums and the wet looper provide the heat and time, respectively, for the asphalt to penetrate the felt. The saturated felt then passes through water-cooled rolls onto the finish floating looper, and then is rolled and cut to product size on the roll winder. Three common weights of asphalt felt are approximately 12, 15, and 30 lb per 108 ft^2 (108 ft^2 of felt covers exactly 100 ft^2 of roof).

EMISSION SOURCE	SCC
ASPHALT BLOWING: SATURANT	3-05-001-01
ASPHALT BLOWING: COATING	3-05-001-02
ASPHALT BLOWING: (GENERAL)	3-05-001-10
FIXED ROOF ASPHALT STORAGE TANKS	3-05-001-30, -31
FLOATING ROOF ASPHALT STORAGE TANKS	3-05-001-32, -33

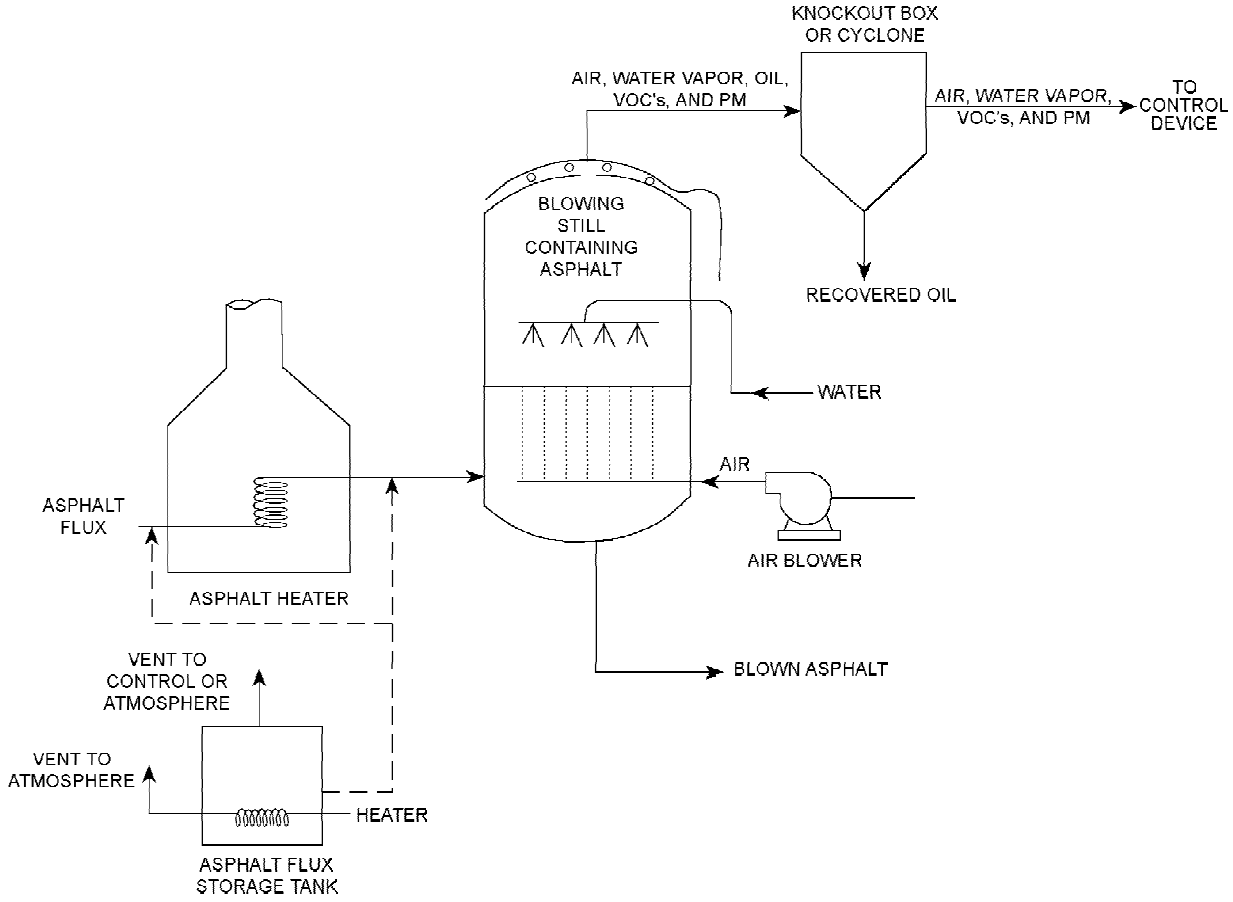

Figure 11.2-1. Asphalt blowing process flow diagram.[1,4]
(SCC = Source Classification Code)

EMISSION SOURCE	SCC
DIPPING ONLY	3-05-001-11
SPRAYING ONLY	3-05-001-12
DIPPING/SPRAYING	3-05-001-13
DIP SATURATOR, DRYING IN DRUM, WET LOOPER, AND COATER	3-05-001-16
DIP SATURATOR, DRYING-IN DRUM, AND COATER	3-05-001-17
DIP SATURATOR, DRYING-IN DRUM, AND WET LOOPER	3-05-001-18
SPRAY/DIP SATURATOR, DRYING-IN DRUM, WET LOOPER, COATER, AND STORAGE TANKS	3-05-001-19
FIXED ROOF ASPHALT STORAGE TANKS	3 05 001 30, 31
FLOATING ROOF ASPHALT STORAGE TANKS	3-05-001-32, -33

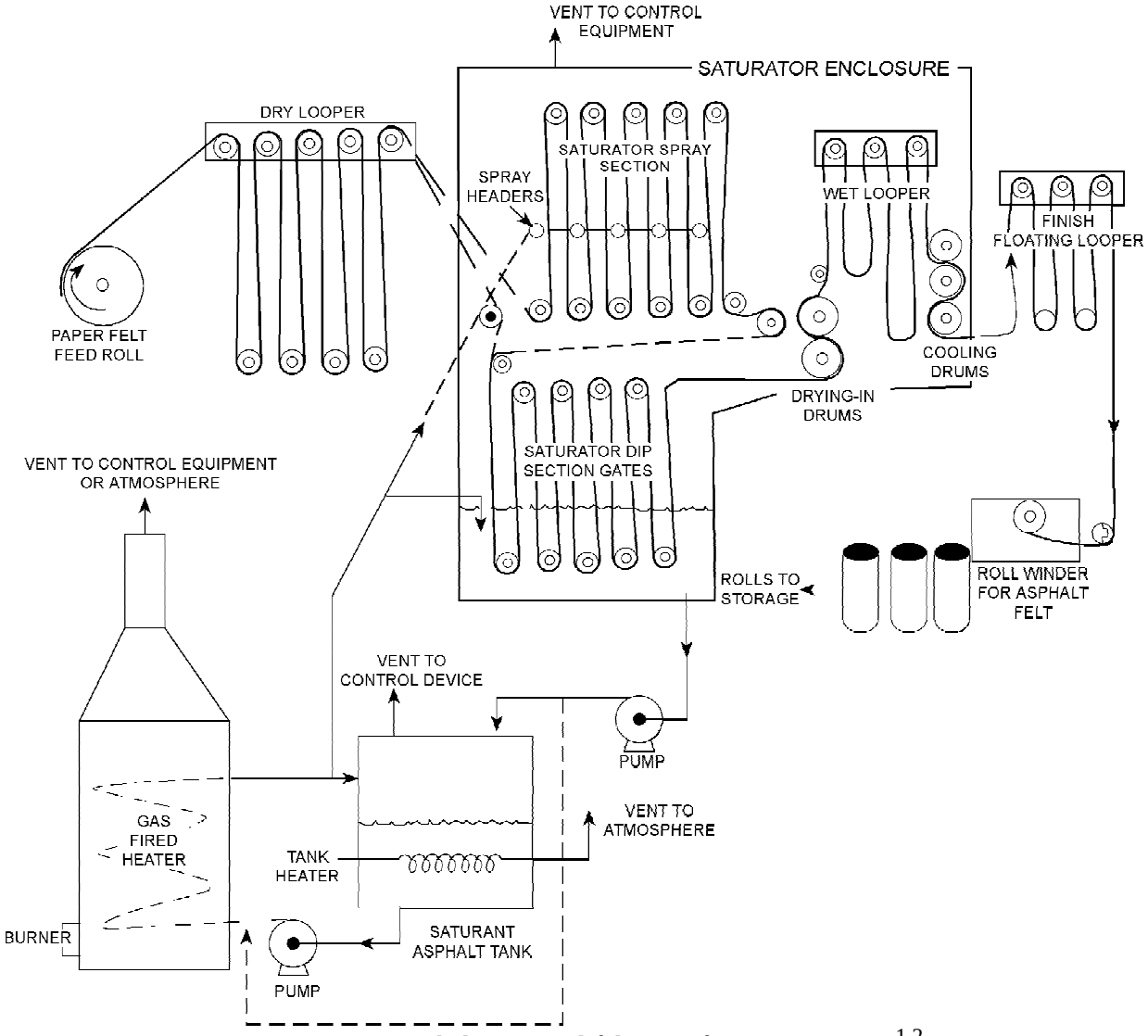

Figure 11.2-2. Asphalt-saturated felt manufacturing process.[1,2]
(SCC = Source Classification Code)

The typical process arrangement for manufacturing asphalt shingles, mineral-surfaced rolls, and smooth rolls is illustrated in Figure 11.2-3. For organic products, the initial production steps are similar to the asphalt-saturated felt line. For fiberglass (polyester) products, the initial saturation operation is eliminated although the dry looper is utilized. A process flow diagram for fiberglass shingle and roll manufacturing is presented in Figure 11.2-4. After the saturation process, both organic and fiberglass (polyester) products follow essentially the same production steps, which include a coater, a granule and sand or backing surface applicator, a press section, water-cooled rollers and/or water spray cooling, finish floating looper, and a roll winder (for roll products), or a seal-down applicator and a shingle cutter (for shingles), or a laminating applicator and laminating operation (for laminated shingles), a shingle stacker, and a packaging station.

Saturated felt (from the saturator) or base fiberglass (polyester) substrate enters the coater. Filled asphalt coating at 180 to 205°C (355 to 425°F) is released through a valve onto the top of the mat just as it passes into the coater. Squeeze rollers in the coater apply filled coating to the backside and distribute it evenly to form a thick base coating to which surfacing materials will adhere. Filled asphalt coating is prepared by mixing coating asphalt or modified asphalt at approximately 250°C (480°F) and a mineral stabilizer (filler) in approximately equal proportions. Typically, the filler is dried and preheated at about 120°C (250°F) in a filler heater before mixing with the coating asphalt. Asphalt modifiers can include rubber polymers or olefin polymers. When modified asphalt is used to produce fiberglass roll roofing, the process is similar to the process depicted in Figure 11.2-4 with the following exception: instead of a coater, an impregnation vat is used, and preceding this vat, asphalt, polymers, and mineral stabilizers are combined in mixing tanks.

After leaving the coater, the coated sheet to be made into shingles or mineral-surfaced rolls passes through the granule applicator where granules are fed onto the hot, coated surface. The granules are pressed into the coating as the mat passes around a press roll where it is reversed, exposing the bottom side. Sand, talc, or mica is applied to the back surface and is also pressed into the coating.

After application of the mineral surfacing, the mat is cooled rapidly by water-cooled rolls and/or water sprays and is passed through air pressure-operated press rolls used to embed the granules firmly into the filled coating. The mat then passes through a drying section where it is air dried. After drying, a strip of adhesive (normally asphalt) is applied to the roofing surface. The strip will act to seal the loose edge of the roofing after application to a roof. A finish looper in the line allows continuous movement of the sheet through the preceding operations and serves to further cool and dry the roofing sheet. Roll roofing is completed at this point is and moves to a winder where rolls are formed. Shingles are passed through a cutter, which cuts the sheet into individual shingles. (Some shingles are formed into laminated products by layering the shingle pieces and binding them together with a laminating material, normally a modified asphalt. The laminant is applied in narrow strips to the backside of the sheet.) The finished shingles are stacked and packaged for shipment.

There are several operations that support the asphalt roofing production line. Asphalt (coating and saturant) is normally delivered to the facility by truck and rail and stored in heated storage tanks. Filler (finely divided mineral) is delivered by truck and normally is pneumatically conveyed to storage bins that supply the filler heater. Granules and back surfacing material are brought in by truck or rail and mechanically or pneumatically conveyed to storage bins.

11.2.3 Emissions And Controls

Emissions from the asphalt roofing industry consist primarily of particulate matter (PM) and volatile organic compounds (VOC). Both are emitted from asphalt storage tanks, blowing stills,

EMISSION SOURCE	SCC
FELT SATURATION: DIPPING ONLY	3-05-001-03
FELT SATURATION: DIPPING/SPRAYING	3-05-001-04
DIPPING ONLY	3-05-001-11
SPRAYING ONLY	3-05-001-12
DIPPING/SPRAYING	3-05-001-13
DIP SATURATOR, DRYING-IN DRUM, WET LOOPER, AND COATER	3-05-001-16
DIP SATURATOR, DRYING-IN DRUM, AND COATER	3-05-001-17
DIP SATURATOR, DRYING-IN DRUM, AND WET LOOPER	3-05-001-18
SPRAY/DIP SATURATOR, DRYING-IN DRUM, WET LOOPER, COATER, AND STORAGE TANKS	3-05-001-19
FIXED ROOF ASPHALT STORAGE TANKS	3-05-001-30, 31
FLOATING ROOF ASPHALT STORAGE TANKS	3-05-001-32, -33

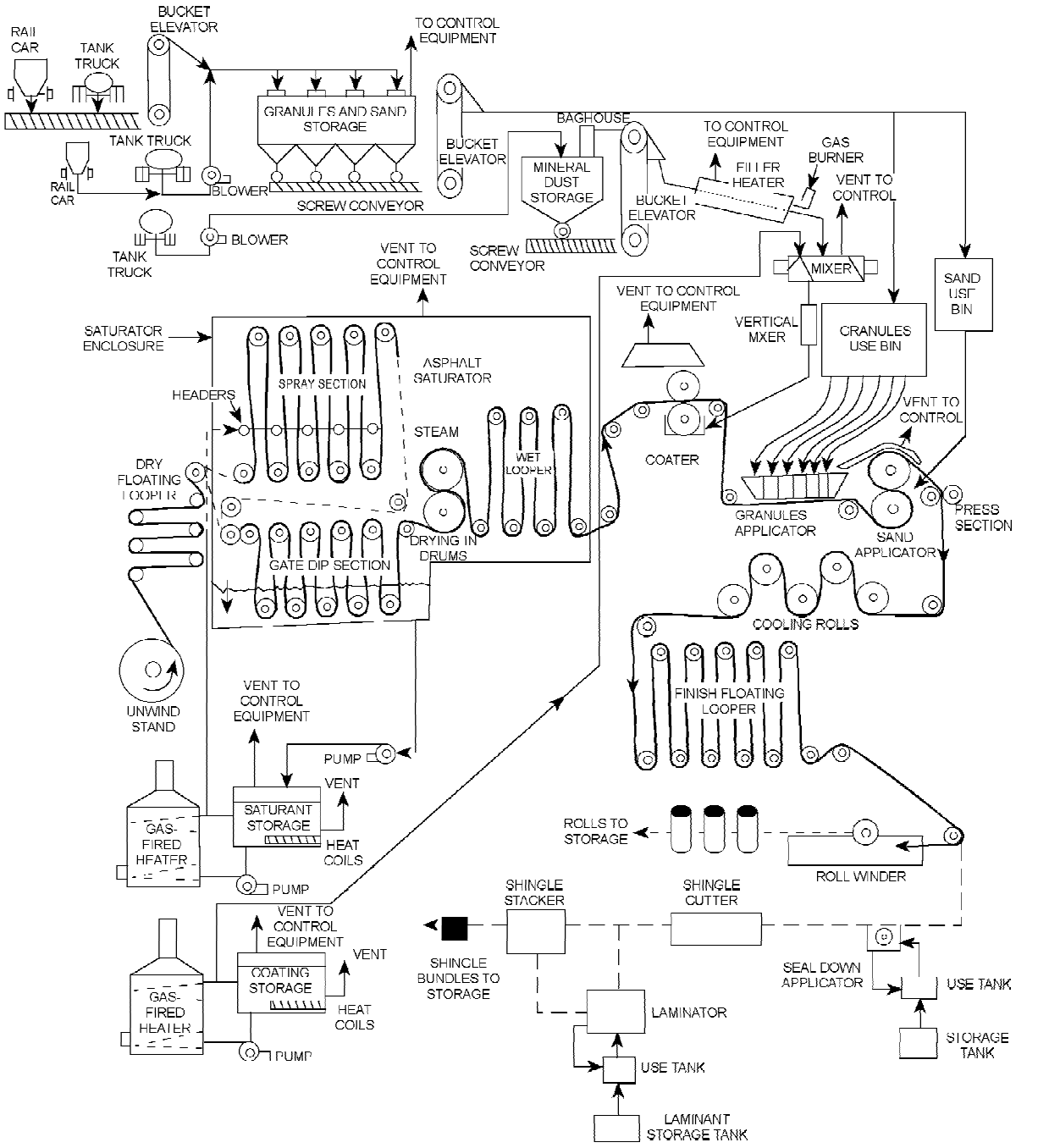

Figure 11.2-3. Organic shingle and roll manufacturing process flow diagram.[1,2]
(SCC = Source Classification Code)

EMISSION SOURCE	SCC
FELT SATURATION: DIPPING ONLY	3-05-001-03
FELT SATURATION: DIPPING/SPRAYING	3-05-001-04
DIPPING ONLY	3-05-001-11
SPRAYING ONLY	3-05-001-12
DIPPING/SPRAYING	3-05-001-13
DIP SATURATOR, DRYING-IN DRUM, WET LOOPER, AND COATER	3-05-001-16
DIP SATURATOR, DRYING-IN DRUM, AND COATER	3-05-001-17
DIP SATURATOR, DRYING-IN DRUM, AND WET LOOPER	3-05-001-18
SPRAY/DIP SATURATOR, DRYING-IN DRUM, WET LOOPER, COATER, AND STORAGE TANKS	3-05-001-19
FIXED ROOF ASPHALT STORAGE TANKS	3-05-001-30-31
FLOATING ROOF ASPHALT STORAGE TANKS	3-05-001-32, 33

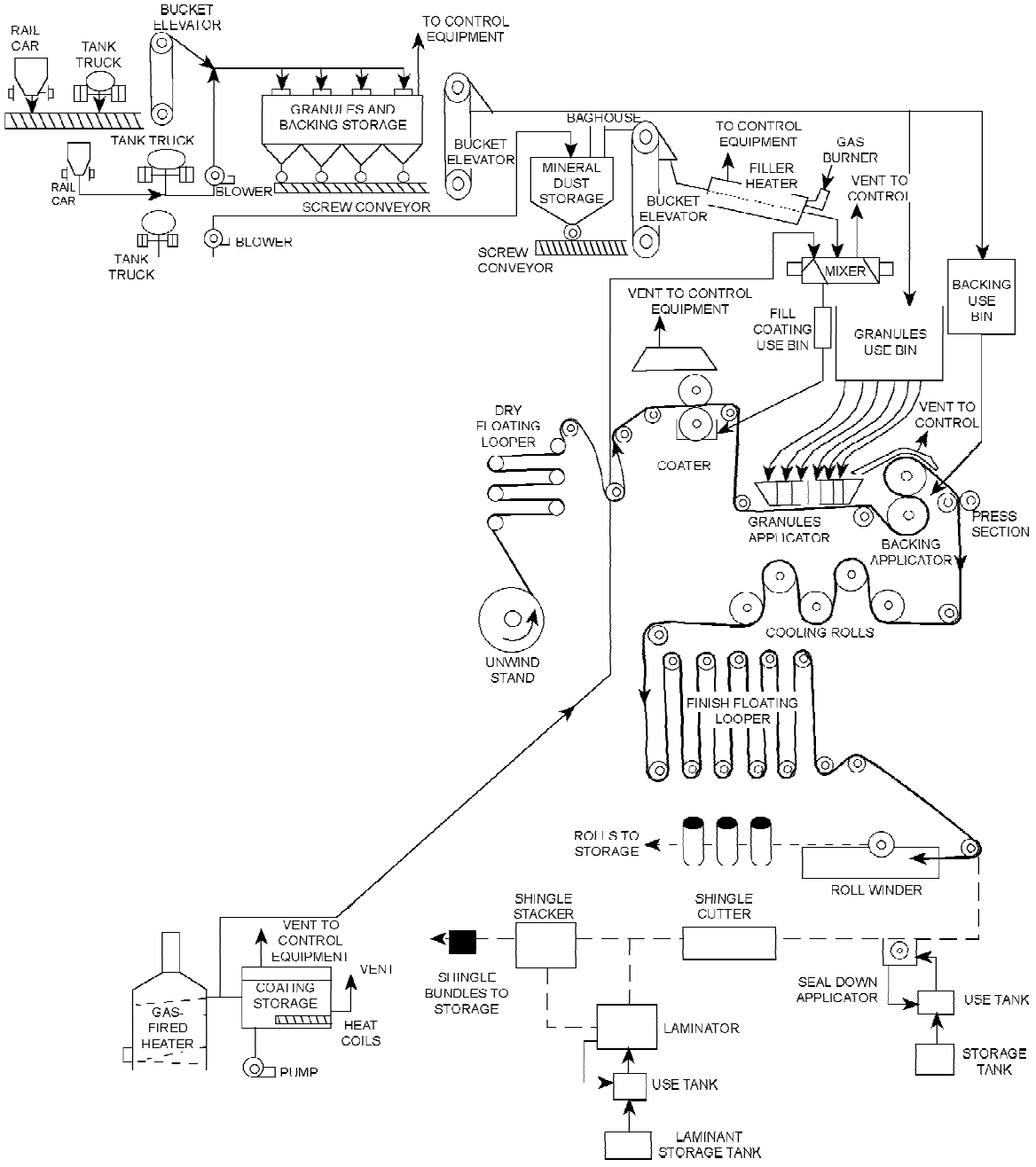

Figure 11.2-4. Fiberglass shingle and roll manufacturing process flow diagram.[1,2]
(SCC = Source Classification Code)

saturators, coater-mixer tanks, and coaters. The PM from these operations is primarily recondensed asphalt fume. Sealant strip and laminant applicators are also sources of small amounts of PM and VOCs. Mineral surfacing operations and materials handling are additional sources of PM. Small amounts of polycyclic organic matter (POM) are also emitted from blowing stills and saturators. Asphalt and filler heaters are sources of typical products of combustion from natural gas or the fuel in use.

A common method for controlling emissions from the saturator, including the wet looper, is to enclose them completely and vent the enclosure to a control device. The coater may be partially enclosed, normally with a canopy-type hood that is vented to a control device. Full enclosure is not always practical due to operating constraints. Fugitive emissions from the saturator or coater may pass through roof vents and other building openings if not captured by enclosures or hoods. Control devices for saturator/coater emissions include low-voltage electrostatic precipitators (ESP), high-energy air filters (HEAF), coalescing filters (mist eliminators), afterburners (thermal oxidation), fabric filters, and wet scrubbers. Blowing operations are controlled by thermal oxidation (afterburners).

Emission factors for filterable PM from the blowing and saturation processes are summarized in Tables 11.2-1 and 11.2-2. Emission factors for total organic compounds (TOC) and carbon monoxide (CO) are shown in Tables 11.2-3 and 11.2-4.

Particulate matter associated with mineral handling and storage operations is captured by enclosures, hoods, or pickup pipes and controlled by fabric filtration (baghouses) with removal efficiencies of approximately 95 to 99 percent. Other control devices that may be used with mineral handling and storage operations are wet scrubbers and cyclones.

In the industry, closed silos and bins are used for mineral storage, so open storage piles are not an emission source. To protect the minerals from moisture pickup, all conveyors that are outside the buildings are covered or enclosed. Fugitive mineral emissions may occur at unloading points depending on the type of equipment used and the mineral handled. The discharge from the conveyor to the silos and bins is normally controlled by a fabric filter (baghouse).

Table 11.2-1 (Metric Units). EMISSION FACTORS FOR ASPHALT ROOFING[a]

Process	Filterable PM[b]	EMISSION FACTOR RATING
Asphalt blowing: saturant asphalt[c] (SCC 3-05-001-01)	3.3	E
Asphalt blowing: coating asphalt[d] (SCC 3-05-001-02)	12	E
Asphalt blowing: saturant asphalt with afterburner[c] (SCC 3-05-001-01)	0.14	D
Asphalt blowing: coating asphalt with afterburner[d] (SCC 3-05-001-02)	0.41	D
Shingle saturation: dip saturator, drying-in drum section, wet looper, and coater[e] (SCC 3-05-001-16)	0.60	D
Shingle saturation: dip saturator, drying-in drum section, wet looper, and coater with ESP[f] (SCC 3-05-001-16)	0.016	D
Shingle saturation: dip saturator, drying-in drum section, and wet looper with HEAF[g] (SCC 3-05-001-18)	0.035	D
Shingle saturation: spray/dip saturator, drying-in drum section, wet looper, coater, and storage tanks[h] (SCC 3-05-001-19)	1.6	D
Shingle saturation: spray/dip saturator, drying-in drum section, wet looper, coater, and storage tanks with HEAF[h] (SCC 3-05-001-19)	0.027	D

[a] Factors represent uncontrolled emissions unless noted. Emission factors in kg/Mg of shingles produced unless noted. Polycyclic organic matter emissions comprise approximately 0.03% of PM for blowing stills and 1.1% of PM for saturators. SCC = Source Classification Code. ESP = electrostatic precipitator. HEAF = high-energy air filter.

[b] As measured using EPA Method 5A. Filterable PM is that PM collected on or prior to the filter, which is heated to 42.2°C (108°F).

[c] Reference 10. Saturant blow of 1.5 hours. Expressed as kg/Mg of asphalt processed.

[d] Reference 10. Coating blow of 4.5 hours. Expressed as kg/Mg of asphalt processed.

[e] References 6-7,9.

[f] Reference 6.

[g] Reference 9.

[h] Reference 8.

Table 11.2-2 (English Units). EMISSION FACTORS FOR ASPHALT ROOFING[a]

Process	Filterable PM[b]	EMISSION FACTOR RATING
Asphalt blowing: saturant asphalt[c] (SCC 3-05-001-01)	6.6	E
Asphalt blowing: coating asphalt[d] (SCC 3-05-001-02)	24	E
Asphalt blowing: saturant asphalt with afterburner[c] (SCC 3-05-001-01)	0.27	D
Asphalt blowing: coating asphalt with afterburner[d] (SCC 3-05-001-02)	0.81	D
Shingle saturation: dip saturator, drying-in drum section, wet looper, and coater[e] (SCC 3-05-001-16)	1.2	D
Shingle saturation: dip saturator, drying-in drum section, wet looper, and coater with ESP[f] (SCC 3-05-001-16)	0.032	D
Shingle saturation: dip saturator, drying-in drum section, and wet looper with HEAF[g] (SCC 3-05-001-18)	0.071	D
Shingle saturation: spray/dip saturator, drying-in drum section, wet looper, coater, and storage tanks[h] (SCC 3-05-001-19)	3.2	D
Shingle saturation: spray/dip saturator, drying-in drum section, wet looper, coater, and storage tanks with HEAF[h] (SCC 3-05-001-19)	0.053	D

[a] Factors represent uncontrolled emissions unless noted. Emission factors in lb/ton of shingles produced unless noted. Polycyclic organic matter emissions comprise approximately 0.03% of PM for blowing stills and 1.1% of PM for saturators. SCC = Source Classification Code. ESP = electrostatic precipitator. HEAF = high-energy air filter.

[b] As measured using EPA Method 5A. Filterable PM is that PM collected on or prior to the filter, which is heated to 42.2°C (108°F).

[c] Reference 10. Saturant blow of 1.5 hours. Expressed as lb/ton of asphalt processed.

[d] Reference 10. Coating blow of 4.5 hours. Expressed as lb/ton of asphalt processed.

[e] References 6-7,9.

[f] Reference 6.

[g] Reference 9.

[h] Reference 8.

Table 11.2-3 (Metric Units). EMISSION FACTORS FOR ASPHALT ROOFING[a]

Process	TOC[b]	EMISSION FACTOR RATING	CO	EMISSION FACTOR RATING
Asphalt blowing: saturant asphalt[d] (SCC 3-05-001-01)	0.66	E	ND	
Asphalt blowing: coating asphalt[d] (SCC 3-05-001-02)	1.7	E	ND	
Asphalt blowing: saturant asphalt with afterburner[c] (SCC 3-05-001-01)	0.0022	D	ND	
Asphalt blowing: coating asphalt with afterburner[d] (SCC 3-05-001-02)	0.085	D	ND	
Shingle saturation: dip saturator, drying-in drum section, wet looper, and coater[e] (SCC 3-05-001-16)	0.046	D	ND	
Shingle saturation: dip saturator, drying-in drum section, wet looper, and coater with ESP[f] (SCC 3-05-001-16)	0.049	D	ND	
Shingle saturation: dip saturator, drying-in drum section, and coater[g] (SCC 3-05-001-17)	ND		0.0095	D
Shingle saturation: dip saturator, drying-in drum section, and wet looper with HEAF[h] (SCC 3-05-001-18)	0.047	D	ND	
Shingle saturation: spray/dip saturator, drying-in drum section, wet looper, coater, and storage tanks[j] (SCC 3-05-001-19)	0.13	D	ND	
Shingle saturation: spray/dip saturator, drying-in drum section, wet looper, coater, and storage tanks with HEAF[j] (SCC 3-05-001-19)	0.16	D	ND	
Asphalt blowing[k] (SCC 3-05-001-10)	ND		0.14	E
Asphalt blowing with afterburner[k] (SCC 3-05-001-10)	ND		1.9	E

[a] Factors represent uncontrolled emissions unless otherwise noted. Emission factors in kg/Mg of shingles produced unless noted. SCC = Source Classification Code. ND = no data. ESP = electrostatic precipitator. HEAF = high-energy air filter.

[b] Total organic compounds as measured with an EPA Method 25A (or equivalent) sampling train.

[c] Reference 10. Saturant blow of 1.5 hours. Expressed as kg/Mg of asphalt processed.

[d] Reference 10. Coating blow of 4.5 hours. Expressed as kg/Mg of asphalt processed.

[e] References 6-7.

[f] Reference 6.

[g] Reference 7.

[h] Reference 9.

[j] Reference 8.

[k] Reference 3. Emission factors in kg/Mg of saturated felt produced.

Table 11.2-4 (English Units). EMISSION FACTORS FOR ASPHALT ROOFING[a]

Process	TOC[b]	EMISSION FACTOR RATING	CO	EMISSION FACTOR RATING
Asphalt blowing: saturant asphalt[c] (SCC 3-05-001-01)	1.3	E	ND	
Asphalt blowing: coating asphalt[d] (SCC 3-05-001-02)	3.4	E	ND	
Asphalt blowing: saturant asphalt with afterburner[d] (SCC 3-05-001-01)	0.0043	D	ND	
Asphalt blowing: coating asphalt with afterburner[d] (SCC 3-05-001-02)	0.017	D	ND	
Shingle saturation: dip saturator, drying-in drum section, wet looper, and coater[e] (SCC 3-05-001-16)	0.091	D	ND	
Shingle saturation: dip saturator, drying-in drum section, wet looper, and coater with ESP[f] (SCC 3-05-001-16)	0.098	D	ND	
Shingle saturation: dip saturator, drying-in drum section, and coater[g] (SCC 3-05-001-17)	ND		0.0019	D
Shingle saturation: dip saturator, drying-in drum section, and wet looper with HEAF[h] (SCC 3-05-001-18)	0.094	D	ND	
Shingle saturation: spray/dip saturator, drying-in drum section, wet looper, coater, and storage tanks[j] (SCC 3-05-001-19)	0.26	D	ND	
Shingle saturation: spray/dip saturator, drying-in drum section, wet looper, coater, and storage tanks with HEAF[j] (SCC 3-05-001-19)	0.32	D	ND	
Asphalt blowing[k] (SCC 3-05-001-10)	ND		0.27	E
Asphalt blowing with afterburner[k] (SCC 3-05-001-10)	ND		3.7	E

[a] Factors represent uncontrolled emissions unless otherwise noted. Emission factors in lb/ton of shingles produced unless noted. SCC = Source Classification Code. ND = no data. ESP = electrostatic precipitator. HEAF = high-energy air filter.

[b] Total organic compounds as measured with an EPA Method 25A (or equivalent) sampling train.

[c] Reference 10. Saturant blow of 1.5 hours. Expressed as lb/ton of asphalt processed.

[d] Reference 10. Coating blow of 4.5 hours. Expressed as lb/ton of asphalt processed.

[e] References 6-7.

[f] Reference 6.

[g] Reference 7.

[h] Reference 9.

[j] Reference 8.

[k] Reference 3. Emission factors in lb/ton of saturated felt produced.

References For Section 11.2

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