



Applicability Of The Asbestos NESHAP To Asbestos Roofing Removal Operations

Guidance Manual

**GUIDANCE ON THE APPLICABILITY OF
THE ASBESTOS NESHAP TO ASBESTOS
ROOFING REMOVAL OPERATIONS**

**U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Radiation
Office of Air Quality Planning and Standards
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GUIDANCE ON THE APPLICABILITY OF THE ASBESTOS NESHAP TO ASBESTOS ROOFING REMOVAL OPERATIONS

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1.0 INTRODUCTION

1.1 BACKGROUND

The asbestos national emission standards for hazardous air pollutants (NESHAP) were initially promulgated in 1973 in accordance with Section 112 of the Clean Air Act (CAA) of 1970. Revised several times to expand coverage and increase stringency, the asbestos NESHAP was revised on November 20, 1990, (55 FR 48406) for the purpose of enhancing enforcement and promoting compliance without altering the stringency of controls or expanding coverage.

Because of the complexities of the asbestos NESHAP and as a result of discussions with representatives of the roofing industry, it became evident that clarification was needed as to the applicability of the asbestos NESHAP to the removal of asbestos-containing roofing material (ACRM), as well as how compliance with the regulation could be achieved. The U.S. Environmental Protection Agency (EPA) decided (1) to develop guidance that documents roof removal practices including those that comply with the asbestos NESHAP and those that are not subject to the NESHAP and (2) to develop an Interpretive Rule that specifies how and when the asbestos NESHAP applies to the removal of ACRM. The Interpretive Rule, published as Appendix A to the Asbestos NESHAP (40 CFR part 61 subpart M), and this guidance document are intended to clarify for industry and enforcement agencies how and under what circumstances the NESHAP applies to the removal of ACRM and how compliance can be achieved.

1.2 OBJECTIVES

The objectives of the guidance are as follows:

- Provide an overview of the roofing industry (Section 2.0), roof systems (Section 3.0), and asbestos roofing products (Section 4.0).
- Describe current roofing removal practices (Section 5.0).
- Describe dust control measures, including removal methods and add-on engineering controls (Section 6.0).
- Describe some of the hazards associated with roof removal (Section 7.0).
- Describe conditions under which the NESHAP is, and is not, applicable to roof removal operations and describe how to achieve compliance (Section 8.0).

While the emphasis in the guidance is on built-up roofing (BUR), attention is also given to other roofing products such as asbestos-cement (A/C) and asbestos-asphalt shingles.

2.0 ROOFING INDUSTRY

2.1 NUMBER AND SIZE OF ESTABLISHMENTS

Roofing contractors are classified in SIC 1761, Roofing, Siding, and Sheet Metal Work. Based on information from the Census of Construction Industries,¹ and the National Roofing Contractors Association (NRCA)² there are about 15,000 firms that do primarily roofing work and between 132,000 and 150,000 workers employed by firms that do roofing primarily.

2.2 TYPE OF PROJECTS: REROOFING VS. RE-COVERING

The NRCA estimates that about 70,000 roof removal jobs are done annually (excluding four-unit or less residential structures).² Based on data collected from its membership,³ the NRCA estimates the percentages of all roofing projects that are reroofing (with roof removal), re-covering (without removal), and new construction. The results of their survey are presented in Table 2-1.

TABLE 2-1. TYPE OF PROJECT

Type	Percent of all projects
New construction	21
Reroofing with roof removal	48
Re-covering without roof removal	31

Source: National Roofing Contractors Association, Annual Market Survey, 1992-93.

3.0 ROOF ASSEMBLIES AND MATERIALS

This section provides a brief review of roof assemblies and materials, including decks, vapor retarders, insulation, membranes and membrane surfacing.

3.1 DECKS

The deck is the structural surface to which the roofing system (including insulation) is applied.⁴ In addition to serving as the structural base for the roof system, decks must meet other design requirements regarding deflection, component-anchorage, dimensional stability, fire resistance and surface character.⁵ Deck materials include: wood plank; wood panel (including plywood, oriented strand board, and waferboard) meeting minimum industry standards; poured gypsum concrete; lightweight insulating concrete; precast concrete or cementitious wood fiber plank; precast-prestressed concrete; reinforced concrete; and steel.⁴ Metal, concrete and wood decks compose the majority of the market.³

Deck design must take into account strength, deflection, drainage or slope, and component anchorage or attachments. Two critical deck design parameters are slope and component anchorage or attachments.

3.1.1 Slope

To provide drainage and prevent the accumulation of rainwater, roofs are sloped. Slope is often provided by the deck, although in some situations it is provided by tapered insulation and sloped insulating fills. Even so-called "flat" roofs should be slightly sloped to promote positive drainage. Suggested slopes for three types of roof are given in Table 3-1.⁴

TABLE 3-1. MINIMUM SLOPE FOR LOW-SLOPE ROOF SYSTEMS

Roof type	Slope (in. per ft)
Coal-tar, aggregate covered BUR	0.125
Other types of BUR and single-piles	0.25
Mineral-surfaced, roll roofing	1 - 4+

Source: National Roofing Contractors Association, The NRCA Roofing and Waterproofing Manual. July 1992.

3.1.2 Attachments

To prevent wind uplift from removing the roof membrane from the insulation or deck, or removing the roof insulation from the deck, attachment is essential. Two basic methods of attaching roof system components are

- Mechanical fastening (such as nailing, screwing, etc.)
- Adhering (such as with adhesives or asphalt*).

3.2 VAPOR RETARDERS

In cold weather, water vapor flows upward from a heated, moist interior to a colder, generally drier exterior. The use of insulation in roof systems shifts the dewpoint from under the roof system to within the roof system. Condensation of water vapor within the roof systems may damage the insulation or result in liquid water leaking into the space below. Condensate also may freeze and expand, damaging the roof system. To prevent interior moisture from damaging the roof system, a vapor retarder is often employed.

* Asphalt is a dark brown to black cementitious material in which the predominating constituents are bitumens, which occur in nature or are obtained in petroleum processing.⁴ Asphalts are designated as Types I through IV, with softening points and viscosities increasing with the type designation. Additional information on asphalts is presented in Section 3.4.1.

A variety of materials are used as vapor retarders, including one or two plies of asphalt-saturated felt adhered with bitumen; vinyl or polyethylene film; polyvinyl chloride (PVC) sheets; aluminum foil; and laminated kraft paper sheets with a bitumen-sandwiched or bitumen-coated kraft paper.

In temperate humid climates during much of the year, water vapor flows in the opposite direction, i.e., down through the roof to the interior.⁵ In these climates, the roof membrane acts as the vapor retarder.

3.3 THERMAL INSULATION

Four categories of insulation are used in low-slope roof systems:

- Rigid board insulation
- Dual-purpose deck and insulating panels
- Poured-in-place insulating concrete fills
- Sprayed-in-place polyurethane foam

In addition, blanket or loose-filled insulation maybe used in joist cavities under the roof deck.

Rigid board insulation includes wood and vegetable fiber boards, foamed plastics, rigid glass fibers, perlite, cellular glass, mineral fiberboard, and poured lightweight insulating concretes. Preformed structural wood-fiber decks made of cement-coated wood fibers (e.g., Tectum®) also serve as insulation. Lightweight insulating concretes contain perlite (siliceous volcanic glass), or vermiculite (expanded mica) aggregate and Portland cement. Polyurethane foam is the principal sprayed-in-place plastic foam.

Insulation for steep-sloped roofs is often applied under the deck. Insulation used in nonresidential, low-sloped roofs is summarized in Table 3-2.⁶

TABLE 3-2. INSULATIONS USED IN NONRESIDENTIAL,
LOW-SLOPED ROOFING PROJECTS

Insulation	Percent of projects
Polyisocyanurate	43.3
Perlite	21.3
Expanded polystyrene	9.8
Extruded polystyrene	4.3
Glass fiber	6.4
Cellular glass	0.7
Phenolic foam	2.9
Composite	4.0
Other	7.3

Source: National Roofing Contractors Association, 1991/1992
NRCA Market Survey.

3.4 MEMBRANES

Roofing contractors' experiences with various low-sloped membranes, are summarized in Table 3-3.⁶ Built-up roof and ethylene propylene diene monomer (EPDM) membranes are currently the most frequently used.

3.4.1 Built-up Roof

A diagram of a typical built-up roof is shown in Figure 3-1.⁷ Built-up roof membranes consist of alternating layers of bitumen and roofing felt that may be surfaced with an aggregate. Bitumen is (1) a class of amorphous, black or dark colored (solid, semi-solid or viscous) cementitious substances, natural or manufactured, composed principally of high-molecular-weight hydrocarbons, soluble in carbon disulfide, and found in asphalts, tars, pitches and asphaltites; (2) a generic term used to denote any material composed principally of bitumen.⁴

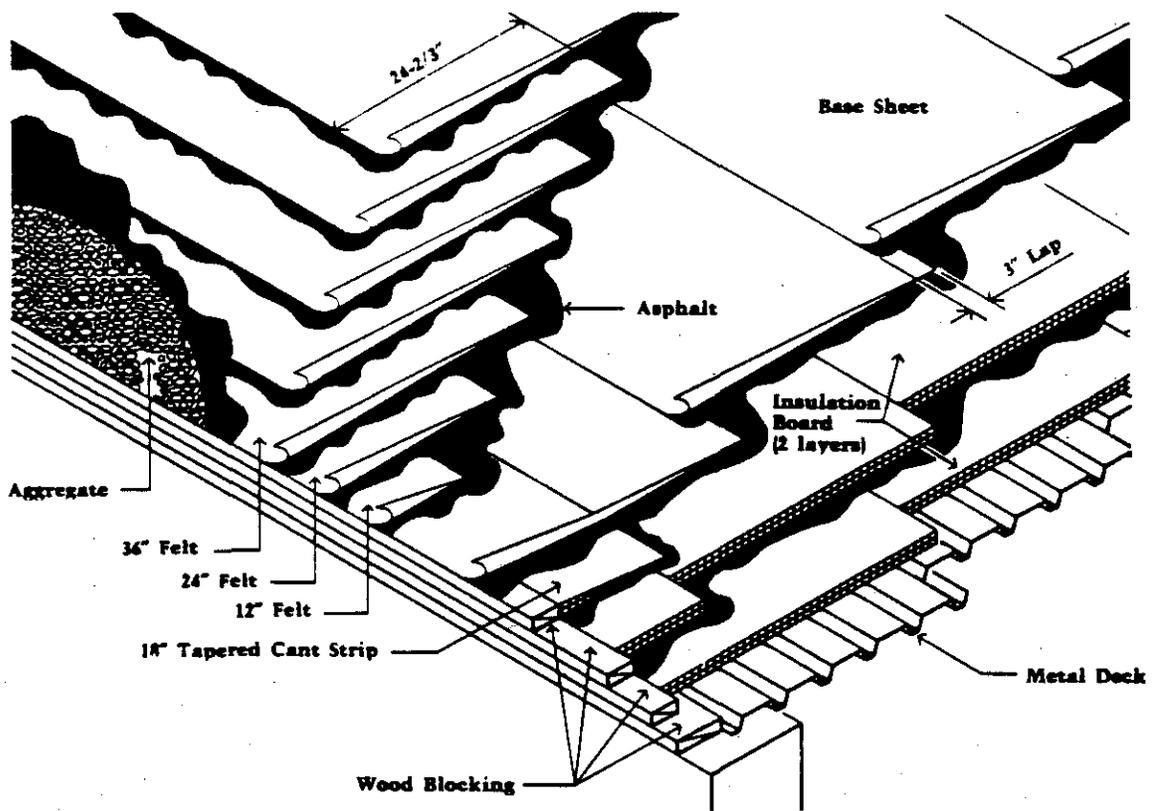
Both petroleum asphalts and coal tar, the bitumens used in built-up roofing, have the following desirable properties:

- Good resistance to water penetration and low water absorptivity
- Good weather durability

TABLE 3-3. MEMBRANES USED IN NONRESIDENTIAL ROOFING PROJECTS

Membrane	Percent of projects
Built-up roofing	30.4
Ethylene propylene diene monomer (EPDM)	27.3
Modified bitumen-APP	11.1
Modified bitumen-SBS	9.5
Asphalt shingles	5.6
Polyvinyl chloride (PVC)	3.4
Chlorosulfonated polyethylene (CSPE) (e.g. Hypalon)	2.3
Tile	1.8
Other single-ply	1.7
Metal-architectural	1.7
Metal-structural	0.4
Polyurethane foam	0.9
Liquid-applied	0.4
Other	3.5

Source: National Roofing Contractors Association, 1991/1992
NRCA Market Survey.



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Figure 3-1. Typical built-up roof.

- Good internal cohesion and adhesion
- Thermoplasticity⁵

The bitumen is used as an adhesive as well as a waterproofing layer.⁴ The roofing felts stabilize and reinforce the system. The aggregate protects the membrane from the effects of sunlight and weathering. Between the plies of roofing felt, bitumen is mopped, typically at 20 to 35 lb/square (a square is 100 ft²).⁴ The top layer, or flood coat, of bitumen is applied at 60 lb/square, allowing about half of the aggregate to become imbedded in it.

The primary advantage of asphalt is that it comes in a wide range of viscosities; hence, high viscosity (high resistance to flow) asphalts are available for slopes up to 6 in./ft. In contrast, coal tar bitumen has viscosities about the same as dead-level (Type I) asphalt and, thus, is generally only appropriate for slopes of 1/4 in./ft or less.⁴

The predominant reinforcing material used in roofing felts is glass fiber. Asbestos was manufactured and used as a reinforcing material in roofing felts until about the early 1980s, after which its use and manufacture for that purpose were discontinued.

3.4.2 Single Ply Membrane

Synthetic, single-ply membranes can be classified by application technique and design. They may be sheet- or fluid-applied and designed as fully or partially adhered, mechanically attached or loose-laid and ballasted membranes. They may also be classified as thermosetting, e.g., EPDM; thermoplastic, e.g., PVC, chlorinated polyethylene (CPE), and polyisobutylene membranes (PIB); and modified bitumen.

3.4.3 Shingles

A shingle is defined as a small unit of prepared roofing material designed for installation with similar units in overlapping rows on inclines normally exceeding 25 percent.⁴

3.4.3.1 Asphalt Shingles. Asphalt shingles are made by treating rolls of organic base mats (felts) or fiber glass base mats with asphalt and cutting them to a desired size and shape.⁸ The top surface of shingles is covered with ceramic-coated granules to protect the asphalt coating from the harmful effects of sunlight and to add some fire resistance.

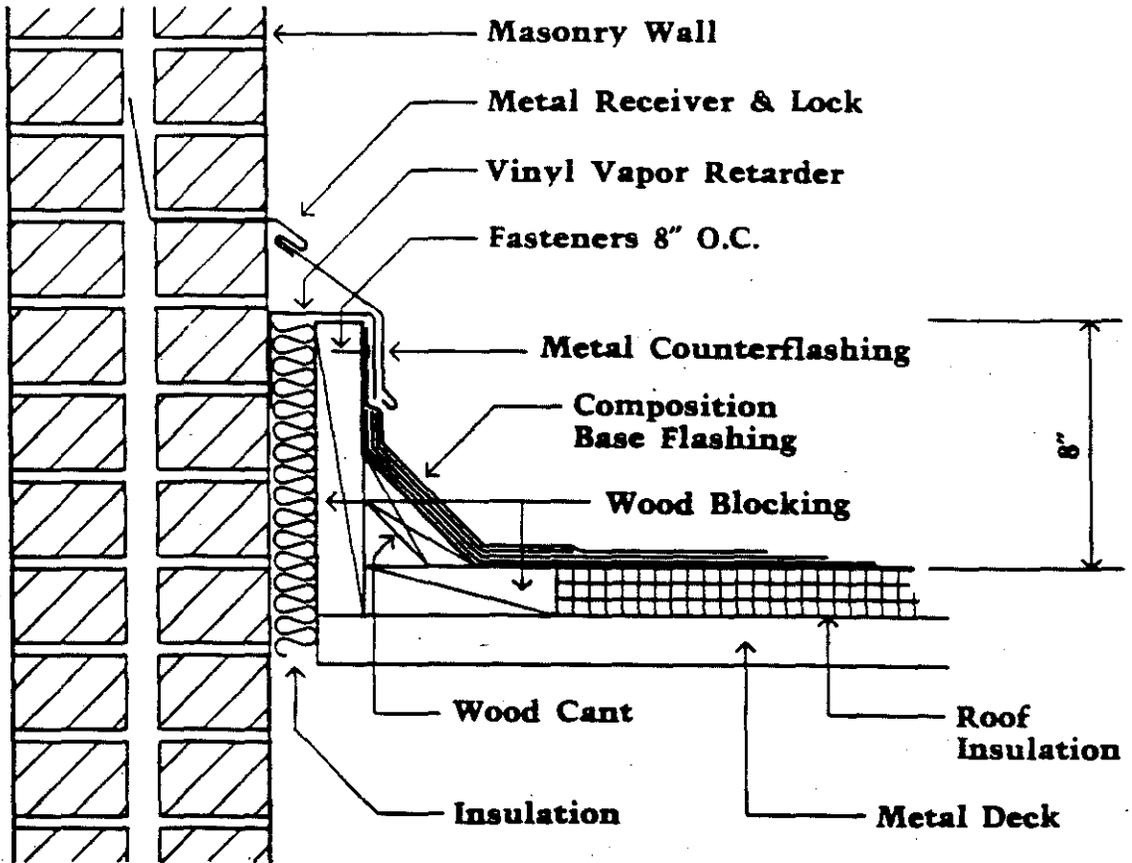
3.4.3.2 A/C Shingles. A mixture of asbestos, cement and silica is processed to form A/C sheet with an asbestos content ranging from 15 to 40 percent. In turn, A/C shingles (no longer manufactured in the U.S.) were cut from flat A/C sheet in sizes ranging from 9 in. by 16 in. to 14 in. by 30 in. A/C shingles were extremely durable, lasting from 30 to 50 years, and were produced in a variety of styles and colors. A/C shingles were attached to the roof in the same way as asphalt shingles, i.e., with roofing nails. Pilot holes for attachment were routinely predrilled or punched at the primary manufacturing plant.⁹

3.4.4 Flashing

Flashing is the system used to seal membrane edges at walls, expansion joints, drains, gravel stops, and other places where the membrane is interrupted or terminated. Base flashing covers the edge of the membrane, and cap flashing or counterflashing shields the upper edges of the base flashing.⁴ An application of flashing is illustrated in Figure 3-2.⁷

Typically, base-flashing materials include conventional saturated and coated felts, reinforced/laminated asbestos felt and scrim (a durable, plain-woven fabric), fiberglass or cotton wovens impregnated with bitumens, vinyls, neoprenes, and butyl rubber. Asbestos flashing have not been manufactured in the U.S. since about the early 1980s.

Because they are exposed, counterflashings are usually rigid and durable; metals including copper, aluminum, galvanized steel, stainless steel, and lead have been used. However, bituminous materials similar to the base flashing also may be used.⁵



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Figure 3-2. Base flashing.

3.5 MEMBRANE SURFACING⁵

3.5.1 Aggregate for Built-up Roofing

Aggregate, 3/16 to 3/4 in. in size, embedded in the bituminous flood coat is a common surfacing for built-up roofs. Common roof aggregates are river-washed gravel, crushed stone, and blast furnace slag. Gravel is typically applied at a rate of 400 to 500 lb/square, and slag is applied at a rate of about 300 to 400 lb/square.⁴ Approximately 50 percent of the aggregate is typically embedded in the flood coat.⁵

An advantage of surfacing with a flood coat of bitumen and aggregate is that it results in a very durable surface. Other benefits of aggregate surfaces are

- Shields the membrane from solar radiation
- Resistance to bitumen erosion by wind and water, and to heat aging
- Impact resistance
- Fire resistance
- Wind-uplift resistance
- Reduced membrane temperature

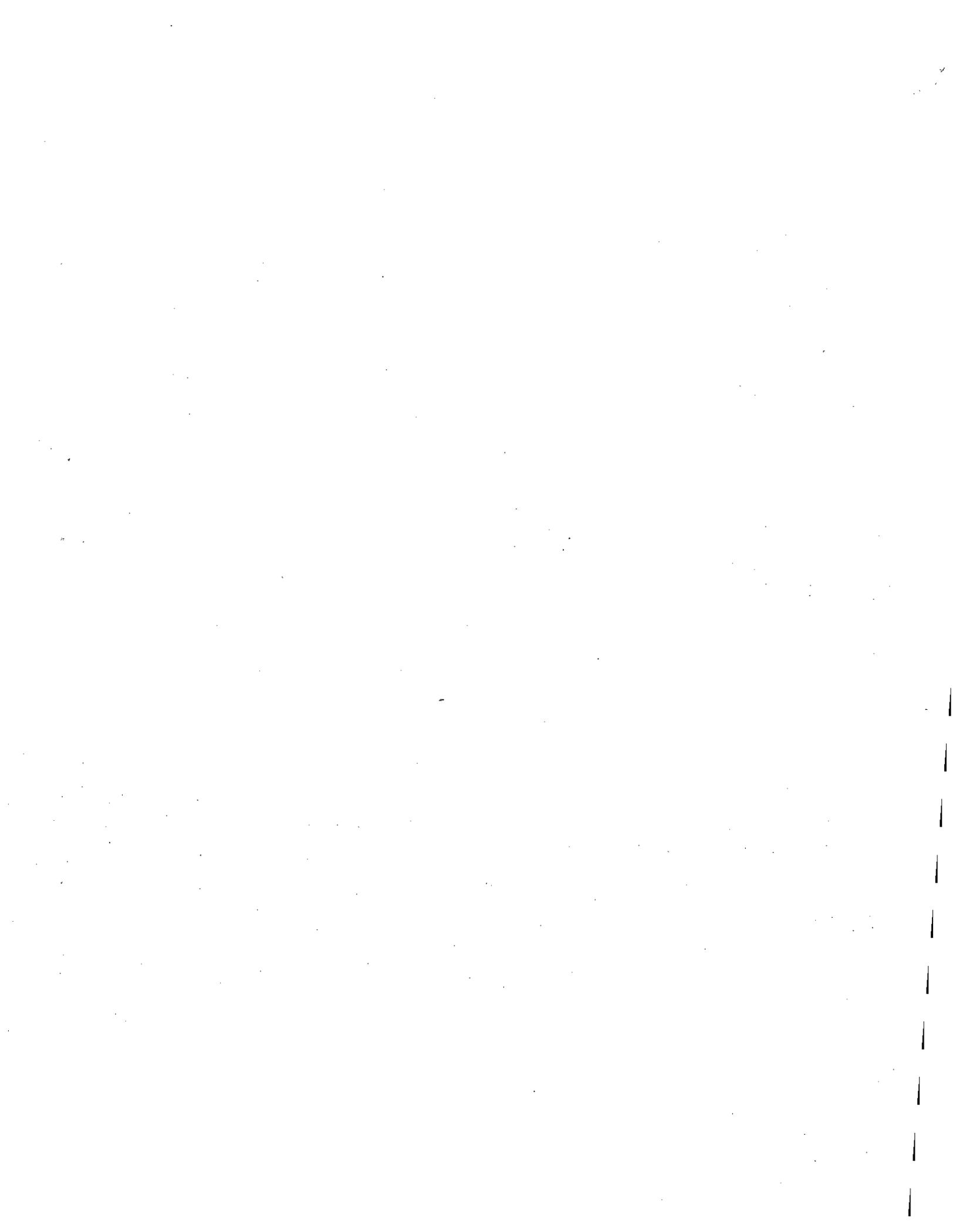
3.5.2 Smooth Surface

A smooth-surfaced built-up roof membrane has a top coat of hot, steep asphalt. Some smooth-surfaced built-up roofs are also coated with a reflective coating to reduce roof-surface temperature. Compared to aggregate-surfaced roofs, some advantages of smooth-surfaced membranes are:

- Easier inspection, maintenance, and repair
- Easier installation of new penetrations in the roof
- Easier reroofing or replacement
- Reduction in dead load (300 to 400 lb per square).

3.5.3 Mineral

Mineral-surfaced roll roofing is made of felts often coated with granules of slate, ceramic, or mineral embedded in the weathering grade asphalt on the surface to be exposed.⁵



4.0 ASBESTOS ROOFING PRODUCTS

This section describes various roofing products and their uses with particular emphasis on those that contain (or contained) asbestos. Information on the time periods in which asbestos-containing products were used is provided where available.

4.1 FELTS⁵

Asbestos roofing felts were nonwoven fabrics³ of organic and/or inorganic composition. Organic felts are made of cellulose fibers--pulped wood and felted papers--saturated and coated with coal tar bitumen or asphalt. Asbestos-reinforced felts were saturated and coated with asphalt and were relatively low in cost and widely used.

Asbestos felts conforming to the specifications of ASTM-D250 were made of 85 percent chrysotile and 15 percent organic fibers saturated with asphalt though the ASTM standard was changed frequently over the years. The addition of other organic fibers allowed the felt to absorb more of the asphalt saturant, which asbestos fibers do not absorb. Asbestos felts, like others, are quite thin. For example, dry asbestos felts (before bitumen is added) weighed approximately 9 and 18 lb/square and were 0.023 and 0.047 in. thick, respectively.⁸ Glass fiber mats saturated with asphalt were also used as roofing felts.

The typical use, asbestos content, and time period sold for asbestos felts are given in Table 4-1.¹⁰ Virtually all

TABLE 4-1. ASPHALT-SATURATED AND ASPHALT-COATED ASBESTOS ROOFING FELTS

Common trade name ^a	ASTM specification	Type	Product weight (lb/100ft ²)	Asbestos weight (lb/100ft ²)	Typical use	Time period sold ^b
<u>Asphalt-Saturated</u>						
No. 15 asbestos, perforated, also called asbestos "finishing" felt	D250	I	13-15	6-8	Ply felt for smooth and aggregate BURs, backer felt in flashings, "5" course cold applied "Asbestile" flashings	36-in. width: 1940 to present ^c 32-in. width: before WWII
No. 20 asbestos, perforated "Blue Chip Felt"	D250	III	17-20	9-10	Ply felt for smooth and aggregate BURs	1960s to 1980s
No. 25 asbestos, unperforated "Centurion" Base Felt	D250	IV	21-25	12-14	Uncoated base sheet	1960s to present ^c
No. 30 asbestos, unperforated "Asbestosgard"	D250 None	II	25-28 8-10	15-18 5-7	Shingle underlay Fire-rated vapor retarder	1930s to 1960s 1960s to 1980s
<u>Asphalt-Coated</u>						
Asbestos base felt, also called "No. 45 asbestos base"	D3378	I	37-39	6-8	Base sheet for asbestos BURs	1960s to 1980s
		II	39-43	9-10		
Venting base sheet	D3672	I	68-70	9-10	Base sheet for reroofing	1960s to 1980s
Asbestos base flashing, also called "reinforced asbestos flashing" or "composition base flashing"	None		55-60	15-18	Hot mopped base flashing for BURs	1960s to present
Asbestos base flashing "AB-20"	None		52	6-8	Hot or mastic applied base flashing for BURs	1960s to 1983

Source: The Roofing Industry Educational Institute. Englewood, CO., n.d.

BUR: Built-up roofing.

^a Some felts have a number designation which refers to the weight of the felt, e.g., a No. 15 felt has a weight of 15 lb./100 ft.²

^b Refers to period sold in both the United States and Canada. Little, if any, roofing felt is now used in the United States.

^c No longer being sold.

U.S. production of asbestos roofing felts was discontinued, however, by the early 1980s, in part because of performance-related problems with the product.

4.2 CEMENTS, COATINGS, AND ADHESIVES

Cements, coatings, and adhesives are typically made of asphalt cutback, i.e., solvent-thinned bitumens, and include cold-process roof primers, adhesives, roof and flashing cements, and roof coatings. Typical uses, asbestos contents, and time periods sold for asbestos-containing cements, coatings, and adhesives are shown in Table 4-2.¹⁰

4.3 SINGLE-PLY PRODUCTS

Asbestos was used as a neoprene latex bonded asbestos backing material in a few of the early single-ply roofing systems such as TNA-200 (Tedlar-neoprene-asbestos), PIB membranes, and Hypalon sheets. The PIB membranes were sold between 1960 and 1966.¹⁰ Other single-ply products (e.g. EPDM, PVC, modified bitumen, and CPE) are not and have not in the past been made with asbestos.

4.4 SHINGLES

A/C roofing shingles and asphalt-asbestos roofing shingles have been in use in this country for more than 80 years. Asphalt-asbestos roofing shingles were sold until 1979, but were not used widely; A/C shingles were sold until 1992.

4.5 DECKING

Since the 1930s, corrugated A/C sheets and flat A/C sheets (Transite) have been used as wall cladding, and occasionally as roofing panels; flexible and utility A/C products have been used as decking.¹¹ However, unless damaged, decks are not repaired or removed even if other parts of the roof system are being replaced.⁴

4.6 INSULATION

Asbestos is not and has not been employed in thermal insulation used in roof systems.

TABLE 4-2. ASBESTOS-CONTAINING CEMENTS, COATINGS, AND ADHESIVES

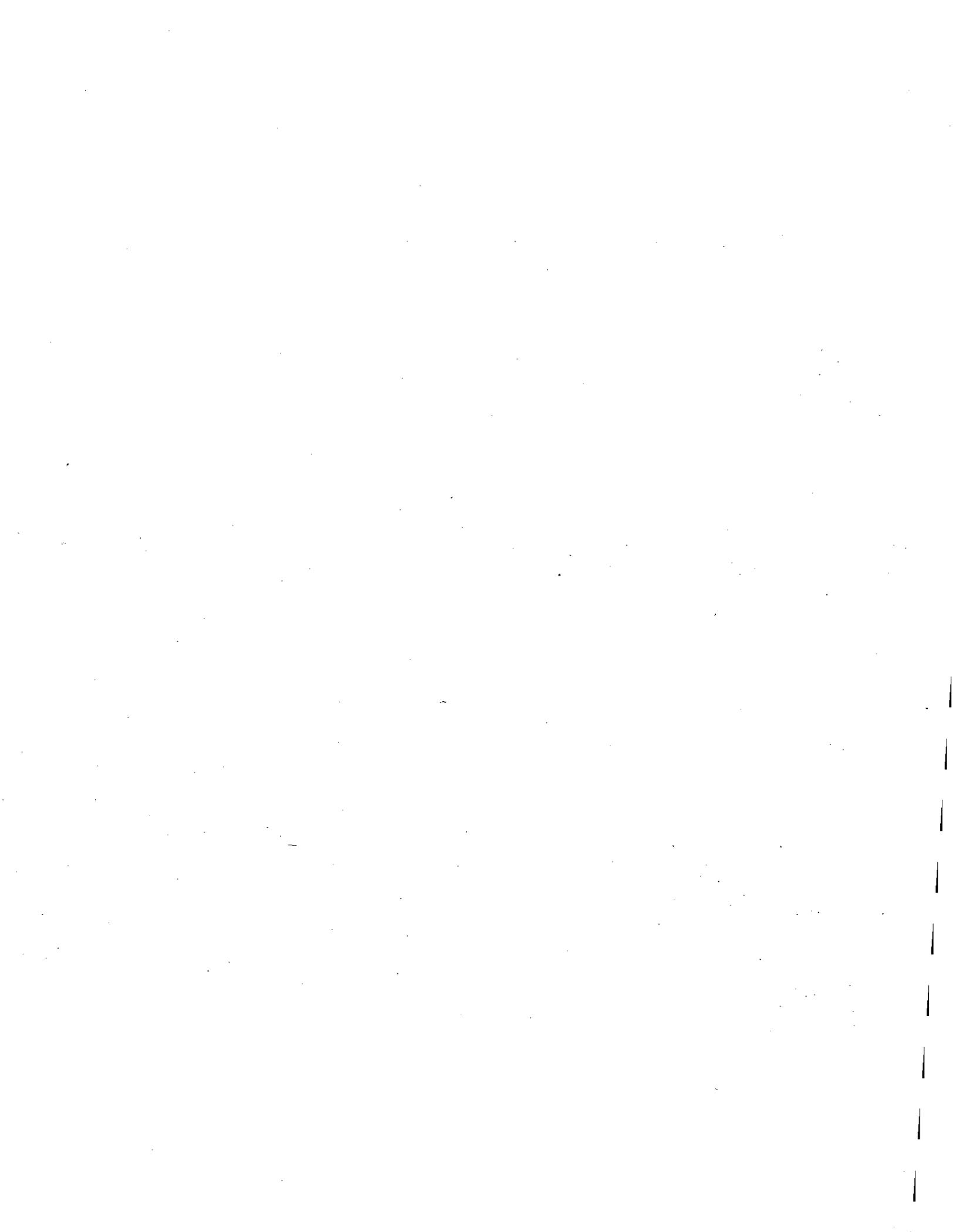
Product	ASTM specification	Type	Asbestos in dry film (lb/100ft ²)	Typical use	Time period sold*
Asphalt roof coating (fibrated)	D2823		1-2	Coat smooth-surfaced roofing	1930 to present
Aluminum roof coating (asbestos fibrated)	D2824	I or II	2-3	Reflective coating for smooth-surfaced roofing and modified bitumens	1930 to present
Asphalt emulsion (asbestos fibrated)	D1227	I	0.1-0.8	Water-based coating for smooth-surfaced roofing and modified bitumens	1930 to present
Cold process cement	D3019	II	2-4	Solvent-based adhesives for coated felt systems (brush grade), used with "split-sheet" roll goods	1930 to present
Asphalt cement (plastic cement, flashing cement)	D2822		6-16	Solvent-based bodied adhesives	To present
Roofing resaturants			2-8	Recoating old BURs, usually regavelled	To present

Source: The Roofing Industry Educational Institute. Englewood, CO., n.d.

*Refers to period sold in both the United States and Canada.

4.7 OTHER ROOF COMPONENTS

Roofing materials not covered in previous sections of Chapter 4 (e.g., vapor retarders, thermal insulation, modified bitumen membranes) are not and have not in the past been made with asbestos. Roofing felts and single-ply membranes presently manufactured and used also do not contain asbestos.



5.0 ROOF REMOVAL PRACTICES

5.1 BUILT-UP ROOFS

Whenever roofs become damaged or deteriorate to the point that leaks are likely, a decision must be made on how to restore the roof to its intended integrity. Usually the course of action requires, at a minimum, the repair of the damaged or deteriorated areas and, in some cases, replacement of the entire roof may be necessary. Even when the decision is to re-cover the existing roof, repairs are occasionally made to the existing roof. Complete roof removal typically involves removal of the membrane, flashing, insulation, and vapor retarder (if present) in the affected area. In some instances, the roof deck may need repair or replacement.

The aspects of roof removal practices discussed here are limited to the methods and equipment used in the removal of the roof membrane and flashing, the components of a roof system where asbestos is most likely to be found. As discussed above, other components of roof systems do not contain asbestos or are not repaired or replaced using methods that trigger coverage under the asbestos NESHAP. Several methods of cutting the roof membrane are available and the method chosen often depends on the nature of the job as well as State and local asbestos regulations. Power roof cutters are used predominantly to cut roof membranes into manageable sections that can be lifted and removed by workers. Manual methods are sometimes used. Other mechanical methods may be used successfully to cut and slice roof membranes, although their use is not yet as well known or as widespread.

Generally, for built-up roofs, the membrane is separated (e.g., by cutting, slicing, punching or shearing) into sections of approximately 2 ft by 2 ft, or 2 ft by 4 ft or other sizes that can be managed by one or two workers and that will fit into a cart or wheel-barrow and a 2-ft diameter chute. The sections are pried up using power roof removers, shovels or tear-off bars, and lifted and stacked on a cart or wheelbarrow. Single-ply membranes may be sliced into long strips and rolled up.

Flashing is usually removed by slicing along the edge of the field of the membrane, next to the flashing, and pulling or prying the flashing loose. The roofing material is taken by cart or wheelbarrow to the roof's edge where it is conveyed by chute, hoist or crane into a container on the ground below. (Although it is not required by the NESHAP, even Category I material should not be dropped to the ground without going through a chute.)

5.1.1 Surface Preparation

Loose, surface gravel is often removed from the existing roof membrane before removal begins.⁵ This will help to reduce the amount of dust generated during roof removal. Gravel can be removed by manual methods--raking, sweeping and shoveling--or by using a power vacuum. Gravel removal by vacuuming can be done dry or wet.¹² The removal of gravel by vacuuming is shown in Figure 5-1. Power brooms like the one shown in Figure 5-2 are also used to remove gravel and consist of a rotating brush that pushes gravel forward and to the side.

5.1.2 Manual Methods

Removal by manual methods usually involves the use of axes, hatchets and utility knives to chop or slice the roof membrane into sections that can be lifted by one or two workers with shovels, spud burs, etc. and loaded onto a cart or wheelbarrow. Manual methods are often used when repairing small areas of damaged membrane or when repairing small areas of flashing, although they can be and occasionally are used to

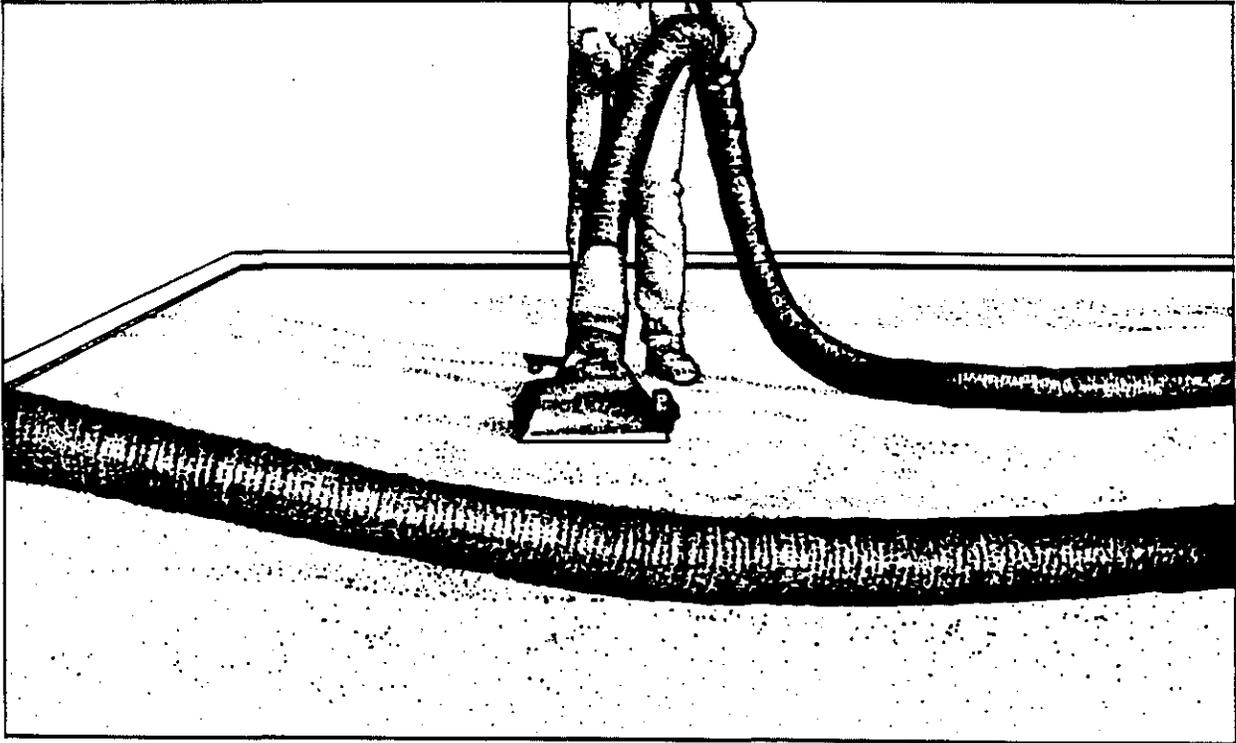


Figure 5-1. Gravel removal by vacuuming.

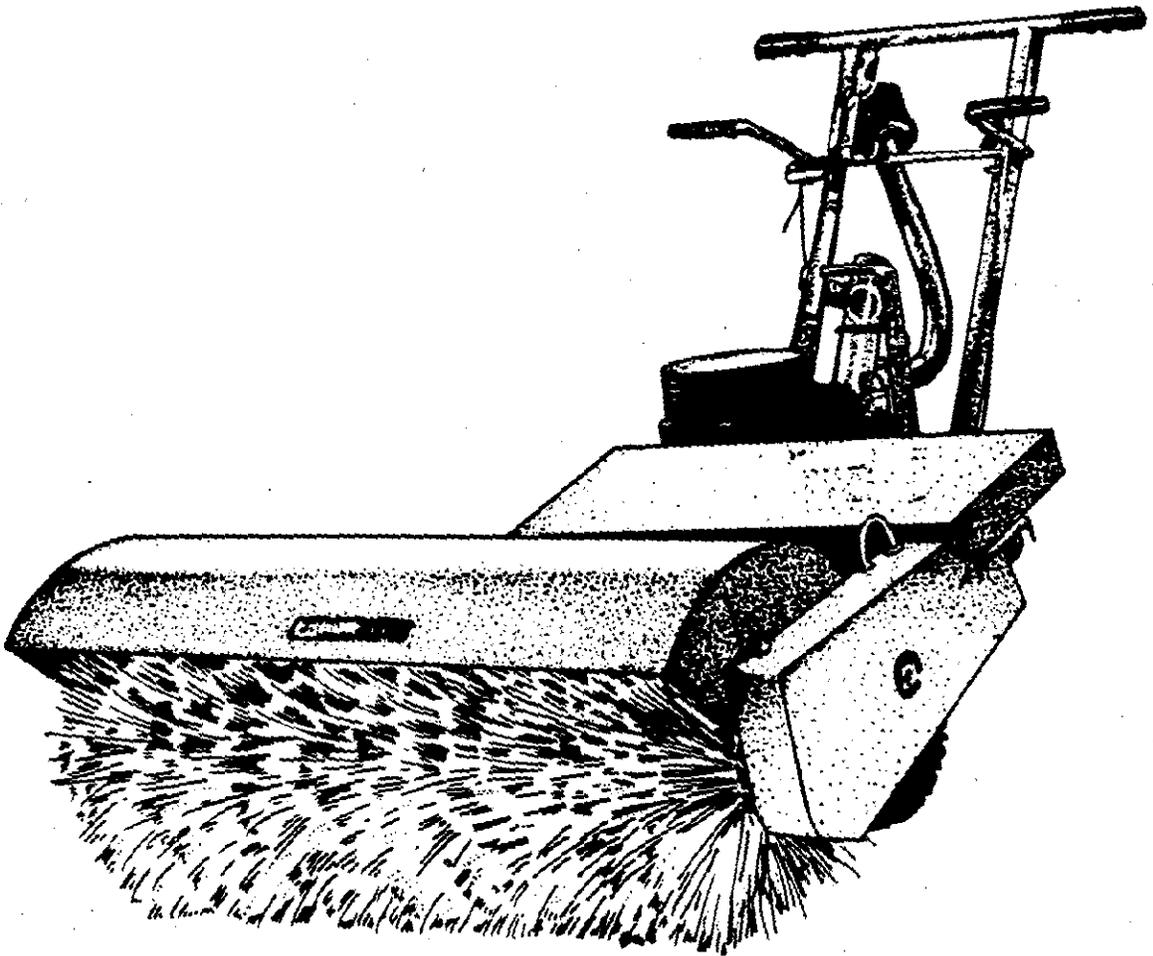


Figure 5-2. Power broom.

remove roof membranes on larger removal jobs. On large, manual roof removal jobs, labor requirements usually increase for the removal phase because it takes considerably more workers to chop or slice the same amount of membrane that can be cut using powered cutting equipment in the same time. Manual removal was estimated by one roofing contractor to increase labor requirements by about one and one-half times.¹³

5.1.3 Rotating Blade (RB) Roof Cutter

RB roof cutters, like the one in Figure 5-3, are used extensively by roofing contractors to cut roof membranes for removal. A gasoline-powered engine mounted on a three- or four-wheeled deck turns a blade mounted near or toward the front of the machine. Standard engines range in size from 5 hp for cutters used for patch work and cutting around roof fixtures such as vents and heating, ventilation, and air conditioning (HVAC) components to 14 hp for cutters equipped with double blades, with 8- and 9-hp engines being typical for the RB roof cutters that do the bulk of the cutting. RB roof cutter blades typically have two cutting edges and are about 12 in. long. The cutting edge of the blade is blunt with about a 1/4-in. kerf as opposed to a tapered, sharp edge. The blades are often carbide tipped to extend blade life. On gravel-surfaced roofs, at a removal rate of about 4,000 ft² per day, a standard blade lasts for 3 to 4 days.¹³ The blade design allows the cutter to be used on gravel-covered roofs, which would dull sharp blades and blades made of softer material. The blade rotates so that the cutting action is from the underside of the membrane when the cutter is moving forward. The cutting can be adjusted to the desired depth depending on the thickness of the membrane, the number of layers present, and the presence or absence of insulation between the membrane and the deck. Because cutting depth is adjustable, RB roof cutters can be used to cut membranes with no underlying insulation if care is taken not to cut completely through the membrane. Because roof systems are not completely uniform in thickness, occasional gouging of the

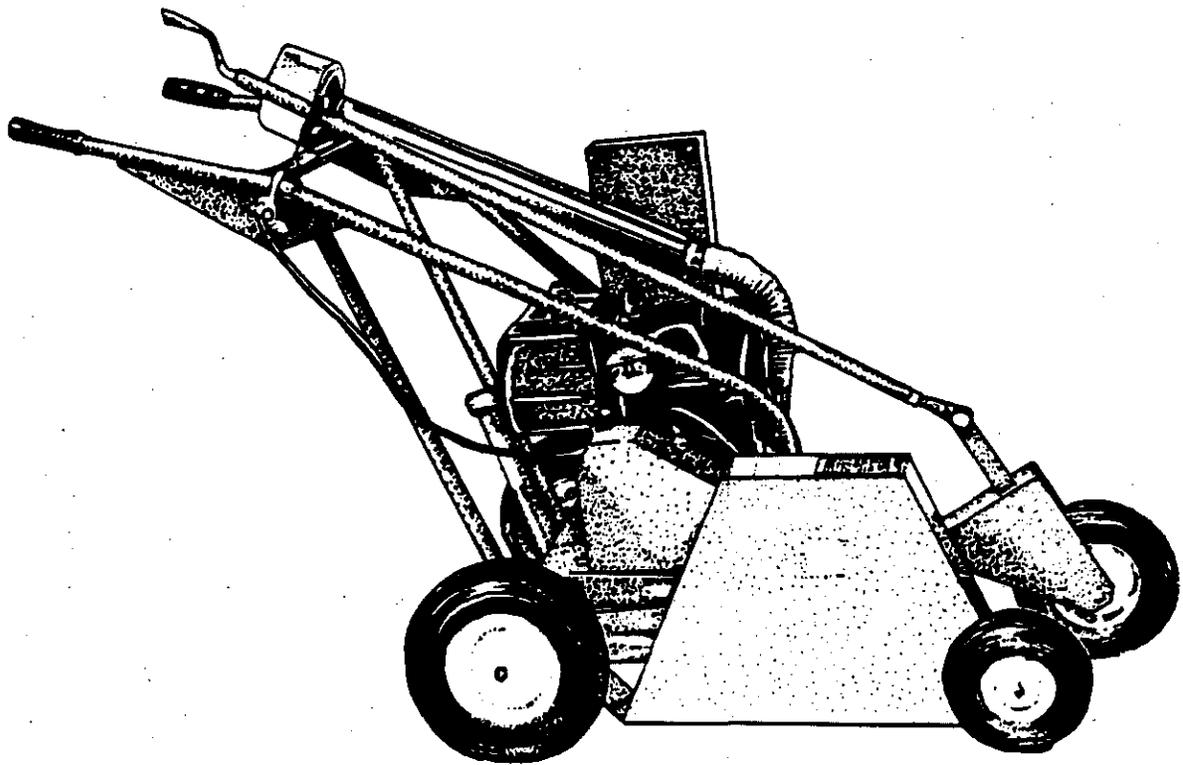


Figure 5-3. Rotating blade roof cutter.

roof deck may occur when using RB power cutters. The blade rotates in a plane perpendicular to the roof surface and is usually housed in a metal blade guard that confines the dust and minimizes the throwing of gravel. Blade guard designs vary. One design completely encloses the blade to within about an inch or less of the roof surface, and another suspends 2-in. length chains from the sides of the shroud to deflect thrown gravel. RB roof cutters are used on both smooth- and gravel-surfaced roofs and are manually propelled. Cutters are commercially available from several manufacturers of roofing equipment.

5.1.4 "Slicer"

A self-propelled, two-wheeled tractor equipped with a blade can be used to slice through smooth roof membranes.¹⁴ Modified by attaching a heavy metal plate to the tractor at the rear, weight is placed on the blade while the plate slides along the roof membrane surface. The blade extends down through a slot cut into the center, near the rear of the metal plate. The lower, slicing portion of the blade is triangular so that, as the blade is pulled through the membrane, the slicing edge is angled back, much like the slicing motion made when using a utility knife. The slicing depth is adjustable. The blade can slice through the membrane and insulation without producing visible emissions or dust or debris. A "slicer" is shown in Figure 5-4. This device may not be suitable for use on aggregate-surfaced roofs because the aggregate would quickly dull the blade. Although this device is not presently available commercially, the slicer can be fabricated using commercially available components. Other similarly adapted roofing equipment has been used to slice roofs by installing a roof cutter blade, perpendicular to the roof surface on the front of a power remover.¹⁵

5.1.5 "Roof Plow"

The "roof plow" operates on a principle similar to that of the "slicer," except that it slices the membrane from below.¹⁶ Because it slices from below, it is not dulled by

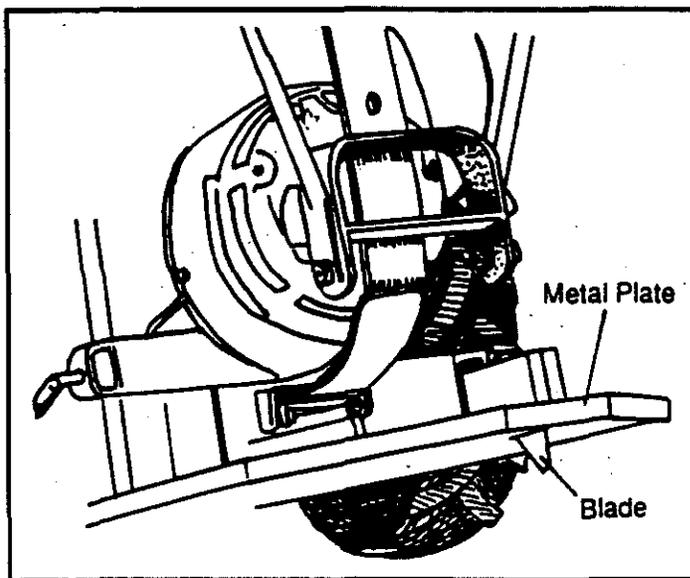
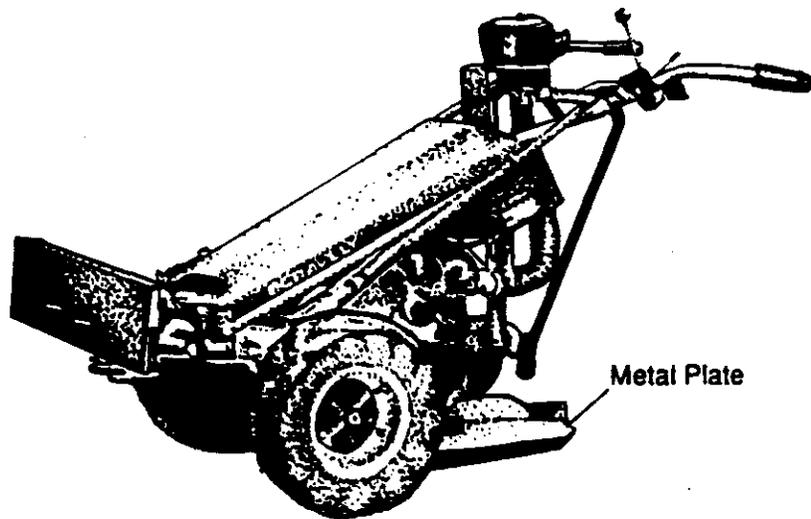


Figure 5-4. Slicer and blade.

roof aggregate and may, therefore, be suitable for aggregate-surfaced roofs. The "plow" shown in Figure 5-5 is attached to the rear of a self-propelled garden tractor much like the slicer and is pulled along through the membrane. To start, the tip of the "plow" blade is inserted under the roof membrane. Because the plow slices the membrane, no dust or debris is created during its use. "Plows" are also not presently available commercially, but, like the slicer, can be fabricated using commercially available materials.

5.1.6 Concrete/Asphalt Planer

A planer is a machine used to remove concrete or asphalt from surfaces at controlled depths and profiles.¹⁷ It uses a series of hardened steel or tungsten carbide cutters that are aligned on four parallel shafts across a definite width of cut and revolve on a drum. The cutters can be spaced to produce various finishes and have a standard penetration depth of 1/4 in. to 3/4 in. Deeper cuts may be achieved on some substrates by modifying the cutters. Some models of planers come equipped with a misting device over the cutter assembly and can be used with a vacuum system designed for the planer. For roof removal purposes, all of the cutters except one set are removed to obtain a single cut. One manufacturer is also considering additional design changes that would permit a cutting depth of up to 2 in. An important feature of the planer is that it can be used in combination with a well designed HEPA-filtered vacuum system. Both the concrete planer and vacuum unit are commercially available. The planer, however, has rarely been used in roof removal projects, because the cutters are easily clogged with bituminous material, and the short cutting depth requires several passes. Figure 5-6 shows a planer with a vacuum system.

5.1.7 Power Remover (Power Tear-off Machine)

Following the separation of roof membrane into sections, workers using shovels and pry bars may manually pry

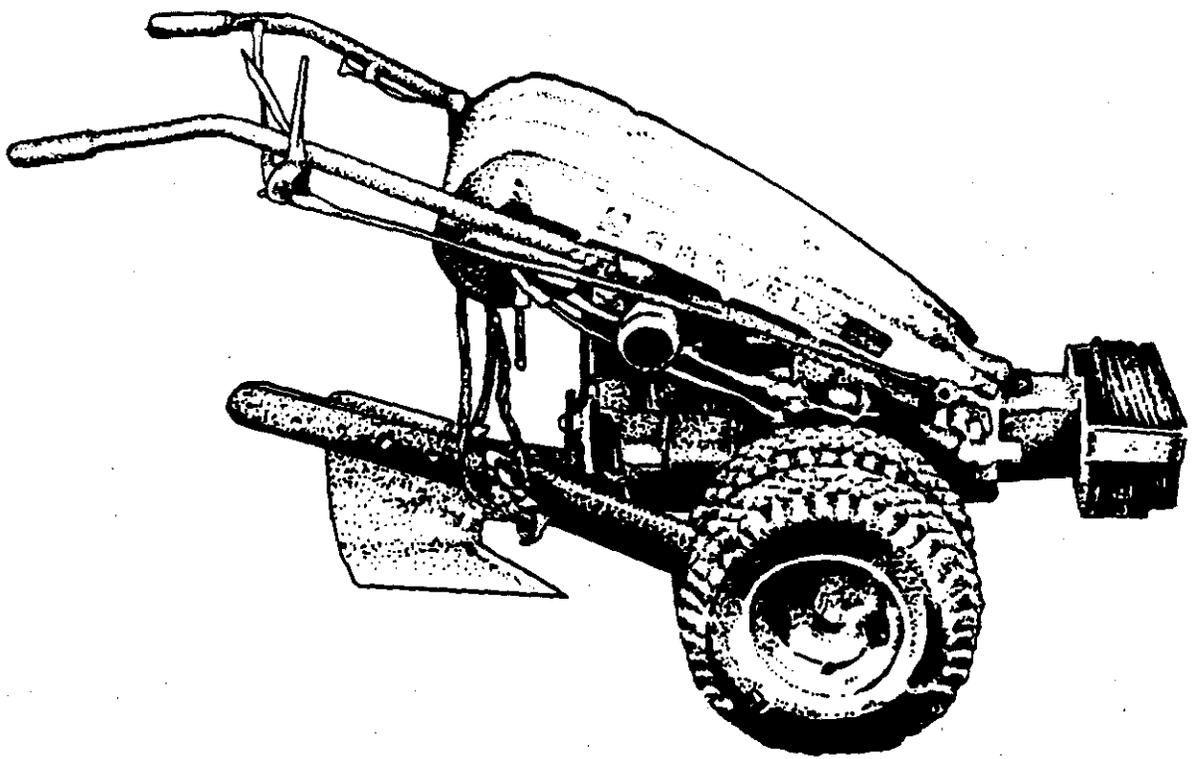


Figure 5-5. Roof plow.

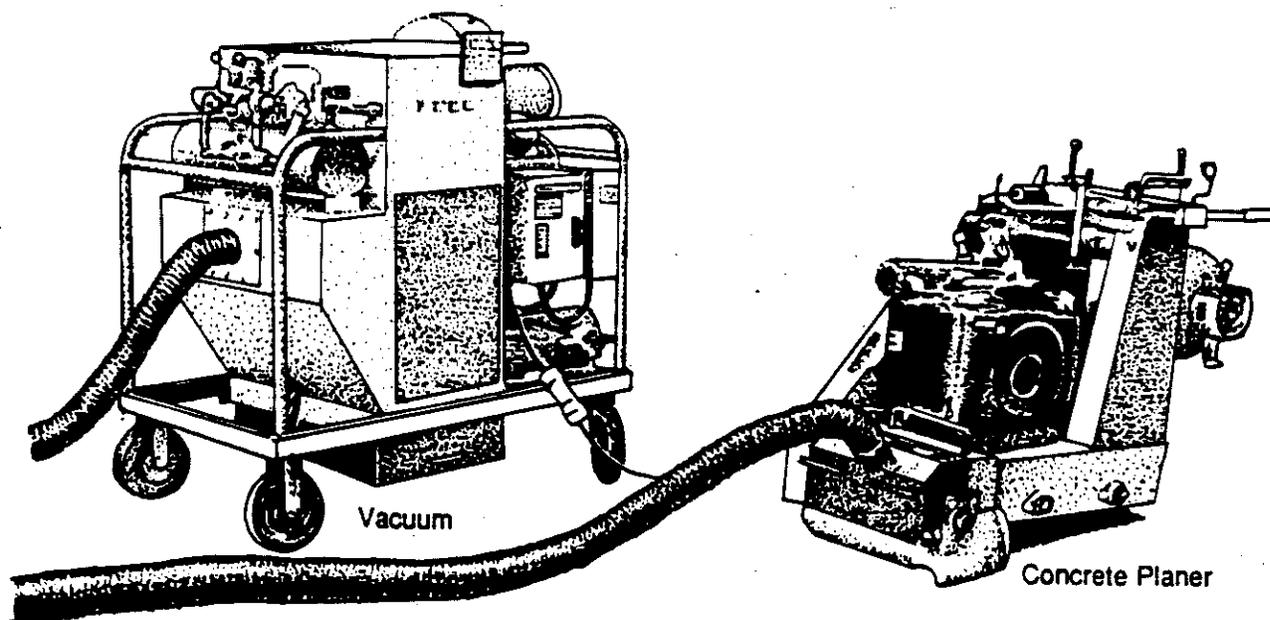


Figure 5-6. Concrete planer and vacuum.

up the pieces and load them onto a cart. An alternative to manually prying up the membrane and other components is to use a power remover, or power tear-off machine.

A power remover consists of a wide actuating blade that can be mounted onto the front of a self-propelled tractor. Power removers also come as a one piece assembly i.e., with the blade and tractor as a single unit.

5.2 SHINGLED ROOFS¹⁸

Shingles are normally used on roofs with inclines exceeding 3 in./ft⁵ and may be either asphalt or cement-based. Because of steep slopes, shingles are removed manually. Removal is accomplished using shovels and/or pry bars, which are inserted under the shingle against the nails, so both the shingle and nails are pried up together. Another method for removing asbestos-cement shingles involves clipping the heads of the nails and then prying off the shingles. Using this procedure, the nails remain and have to be removed separately after the shingles have been removed. Where asphalt-saturated felt underlayment under the shingles contains asbestos and is in good condition, it can usually be rolled up for disposal.

6.0 DUST CONTROL METHODS

Various methods are available for minimizing dust emissions from the removal of asbestos-containing roofing materials. Dust control methods include modifying the way in which the asbestos material is removed as well as add-on dust control devices. The control methods discussed here are intended for use in the removal of asbestos-containing BUR membranes.

6.1 REMOVAL METHODS

The method used to separate the BUR membrane into sections can affect the amount of dust generated. As described in Section 5, the standard RB roof cutter, long used by the roofing industry, uses a blade with a flat 1/4- to 3/8-in.-wide cutting edge. As this blunt edge passes rapidly through the roof system components, i.e., insulation, membrane, and surface aggregate, visible emissions of dust are typically generated.^{13,19} Dust created during the use of the RB roof cutter on an asbestos-containing membrane has been shown to contain asbestos.²⁰ Various methods devised to reduce the amount of dust generated include modification of the standard roof cutting blade and the use of methods that minimize the degree of damage to the roofing materials. For example, it has been demonstrated that by adjusting the cutting depth to cut only the membrane, it is possible to reduce visible emissions.²⁰ In a test where a membrane and insulation were being cut, most of the dust generated came from the insulation materials (only 1 to 3 percent of the sampled material was asbestos.)²⁰

6.1.1 Modified RB Roof Cutter Blade

In an effort to reduce dust levels, a contractor replaced the standard RB roof cutter blade with a thinner steel blade that had been fabricated at a metal shop.¹³ The width of the blade was about 1/8 in. compared to the standard 1/4 in. to 3/8-in.-wide blade. The thinner blade was designed to reduce the amount of material impacted by the blade, thereby, reducing the amount of dust generated. Even though the thinner blade produced less dust and cutting debris than the standard blade, visible emissions and smoke were observed when it was used to cut a dry BUR membrane on a gravel-surfaced roof.¹³

6.1.2 Slicing

Slicing a roof membrane involves pulling a sharp or thin-edged blade through the membrane in a long continuous motion. This differs from the standard RB roof cutter, which has a high-speed, rotating blade that impacts the roof membrane repeatedly to cut a path through it. The slicing action may be either from the top down through the membrane, or from the underside up through the membrane. The slicer and roof plow, described in Section 5, are both examples of prototypical devices that may be used to slice the membrane under some field conditions. Observations of the two different slicing operations showed that slicing produces no visible debris or dust, and can prevent visible emissions without wetting.^{14,19} Slicers and plows are not yet commercially available and may not be suitable for all field conditions or roof surfaces. However, the materials and equipment used to fabricate these machines are readily available. Self-propelled garden tractors can be purchased and the other materials can be readily fabricated at shops that do welding and steel fabrication.

6.1.3 Concrete/Asphalt Planer

As discussed in Section 5, the concrete/asphalt planer is used to impart a particular finish on hard, cured concrete or asphalt concrete surfaces. By removing all but a single

set of cutters, this machine has been used to separate BUR membranes into sections for removal. Various models of concrete planers are equipped with a misting device over the cutter assembly to aid in dust control. In addition, a vacuum system has been designed for use with the concrete planers to control dust.¹⁷ These vacuum units are available with large (150-ft²) paper-pleated filters and are also available with HEPA filters.¹⁷ A 2 hp centrifugal blower generates 150 cfm of suction and a 1 hp air compressor automatically purges the primary filter into a collection tray under the machine. During a demonstration of the concrete planer (set up for roof cutting, i.e., all but one set of cutters removed) and the vacuum unit, dust was effectively controlled and the planer was operated without producing visible emissions.²¹ Planers, however, are not typically used in roof removal operations, and may not be suitable under some conditions.

6.2 WETTING

Wetting has been done in various ways to attempt to control dust emissions from roof removals involving RB roof cutters. Although asphalt materials do not absorb water, the water helps to control dust by adhering to the particles, causing them to settle out faster. One approach is to apply water to the roof surface prior to cutting. This primarily reduces emissions from dust that has collected on the roof. In a test where a local exhaust system had been installed on a RB roof cutter and a skirt added to extend the blade guard to the roof surface, the added precaution of a general wetting of the roof surface further reduced visible emissions. (The roof had been swept and washed prior to cutting).²⁰ Water may also be sprayed during cutting at the point where the roof is being cut by a worker walking beside the cutter. A hand-held, garden-type sprayer or water hose with a spray nozzle is often used to apply water at the point of cutting. (This method is not always appropriate, however, for instance if the insulation is being re-used.)

On RB roof cutters and concrete planers, the blade guard can be modified by installing a spray nozzle on the inside of the blade guard that directs a fine spray of water down at the blade¹³ or the cutters, in the case of the concrete planer. Water is supplied to the blade guard from either a water hose or a garden-type sprayer attached to the cutter. The garden sprayer must be pumped-up occasionally to maintain sufficient pressure in the water bottle. During a roof removal operation using an RB roof cutter equipped with a spray nozzle inside the blade guard that directed a fine spray of water down over the blade, the only emissions observed were some occasional thrown gravel and smoke, apparently the result of friction between the blade and asphalt.¹³ On the same removal operation with no water being sprayed, the cutting of the roof membrane produced copious amounts of brownish dust, apparently from the underlying insulation. Figure 6-1 shows a commercially available roof cutter that has been modified by attaching a spray nozzle to the blade guard. Care must be taken when applying water not to introduce so much that it enters the building or accumulates on the deck. All insulations and some deck materials, especially wood, gypsum, cement wood fiber and cement composition decking, may be adversely affected if they become too wet. Where insulation is present and a fine spray or mist is applied (as opposed to a heavy stream of water), the insulation adsorbs much of the water and prevents any appreciable amounts of water from seeping down to the deck. If the old insulation is to be replaced, this avoids the problems associated with putting down a new membrane over wet insulation.

A method that is intended to produce the same effect as wetting but avoid the potential problems associated with wetting is the use of foam. In this method, a layer of foam, 2 to 3 inches, or more, thick would be put down over the area to be cut. The foam acts to trap dust emitted from cutting operations. Fire retardant foams have been used for this purpose. The foam dissipates after several hours. This

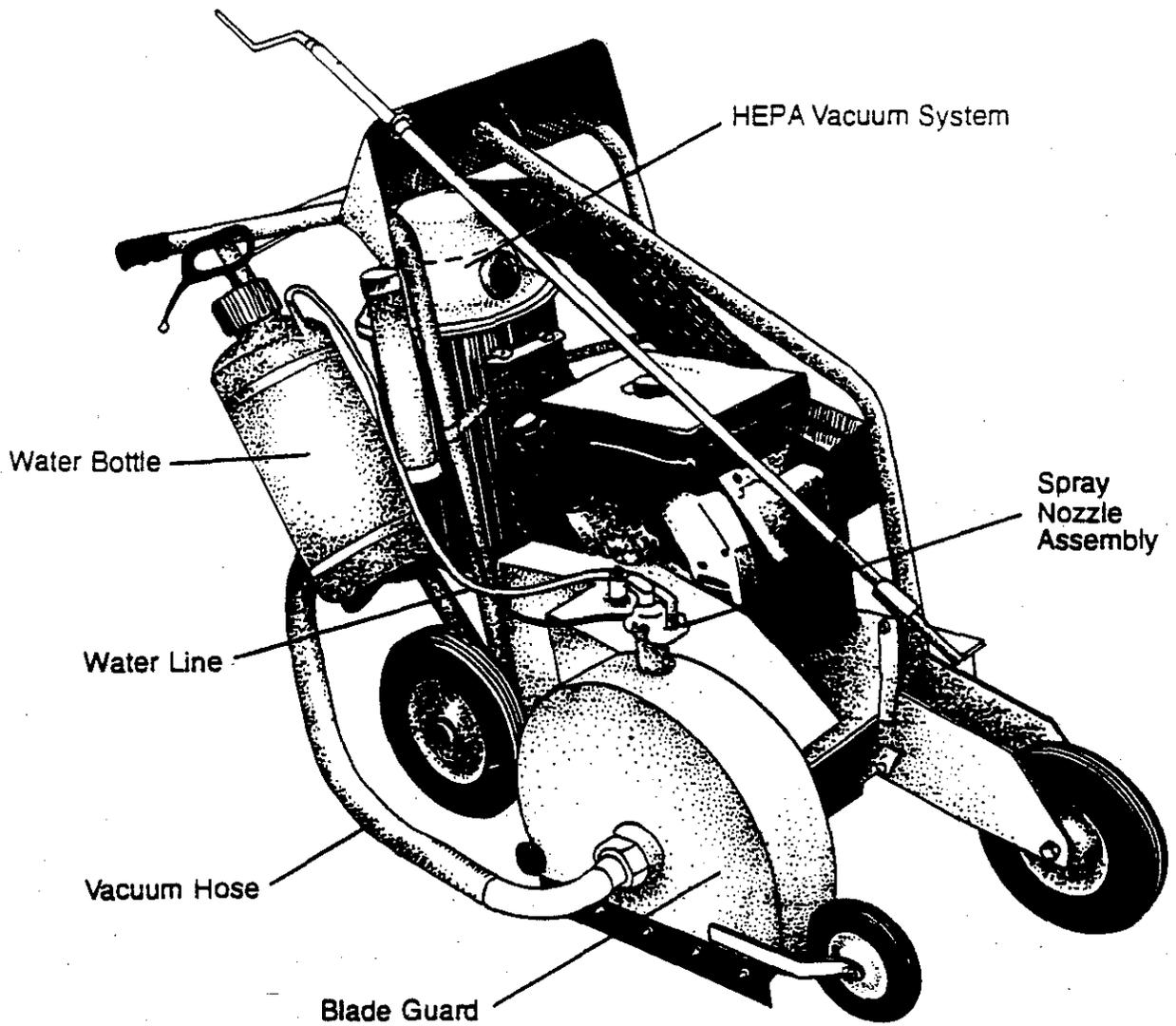


Figure 6-1. Rotating Blade Roof Cutter Equipped with a Spray Nozzle and Vacuum System

method has not been used extensively and may not be suitable for all field conditions or roof surfaces.

6.3 HEPA-FILTERED LOCAL EXHAUST VENTILATION

Local exhaust ventilation and filtration systems have been applied successfully to various types of dust-generating tools and equipment outside of the roof industry, including drills, saws, and concrete planers. They have also been applied to RB roof cutters. A study that evaluated the feasibility of preventing visible emissions from standard RB roof cutting operations found that when a HEPA-filtered local exhaust ventilation system was added to the blade guard, visible emissions were noticeably reduced over cutting without any control, although emissions were still evident.²⁰ By adding a skirt to the blade guard to extend it closer to the roof surface, visible emissions were further reduced to the extent that they were visible only when the cutter was tilted to change directions or when the flexible skirting material added to the blade guard was breached by flying gravel.²⁰ The sizing of vacuum systems has not been studied adequately, but the vacuum should be sufficient to capture the dust generated by the cutting. A roof cutter equipped with a HEPA-filtered vacuum system is illustrated in Figure 6-1. At least one manufacturer of roofing equipment has designed a RB roof cutter with a HEPA filtered vacuum system mounted directly to it, thereby avoiding some of the tripping hazards associated with hoses on the roof surface.

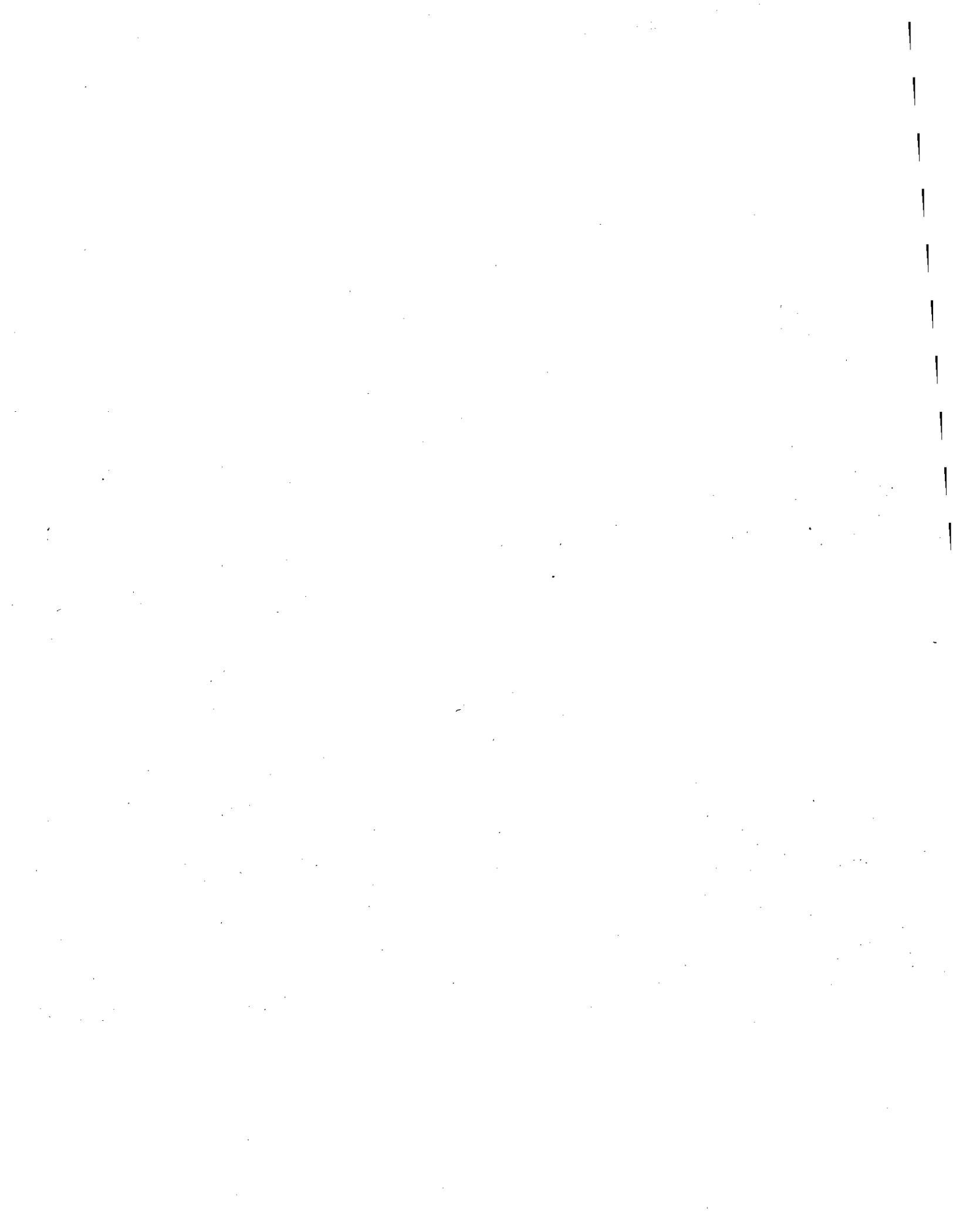
6.4 RE-COVERING VS. REROOFING

An alternative to removal of asbestos-containing roofing is to re-cover the existing roof. This is occasionally done for economic reasons, since it is usually less expensive to place an additional roof membrane over an existing one than it is to remove the old roof and put down a new one. Local building codes and good roofing practices generally discourage multiple re-coverings on the same roof. Several factors determine whether re-covering is a viable alternative, such as

the extent of damage to the existing roof and the structure's load-bearing capacity.

6.5 WASTE HANDLING AND DISPOSAL

The asbestos-containing waste generated during a roof removal job generally includes the asbestos-containing membrane and flashing. The dust created by the use of the RB roof cutter has also been shown to contain asbestos.²⁰ If the dust from cutting is not controlled at the source, it may be blown away from the cutting area and contaminate other parts of the roof. Where controls are implemented, e.g., wetting inside the blade guard, use of local exhaust ventilation with the blade guard, and extending the blade guard down close to the roof surface, most of the dust can be confined to the surface immediately adjacent to the cut. Vacuuming along the cut while still wet is one method for collecting the dust for disposal. When manual or slicing methods are used on roof membranes that are not badly deteriorated, there is no asbestos dust or debris formed. Nonasbestos waste and nonRACM-contaminated waste can be disposed of in landfills separately from RACM waste.



7.0 SAFETY HAZARDS AND PROPERTY DAMAGE

This section reviews the safety and health hazards that normally accompany roof removals, as well as the potential for additional safety hazards and property damage if the asbestos NESHAP is applied to roof removals. This section has relevance to NESHAP inspectors since they will be exposed to many of the same safety and health hazards as roofing workers. It is noted that the responsibility for occupational safety and health problems associated with roof removals lies with OSHA and its state-level counterparts.

7.1 GENERAL

The primary safety and health problems of roof removals include dust inhalation and skin and eye irritation during removal, falls from ladders and roofs and through roof openings, strains, sprains and hazards associated with lifting heavy objects, and the effects of extreme heat.^{22,23} These and other problems may be exacerbated when jobs are rushed.²²

7.1.1 Dust

Use of power brooms to sweep loose aggregate and other deposits from roofs and roof cutters to cut built-up membranes can produce copious amounts of airborne dust. The dust from power brooming is primarily a nuisance dust, although NIOSH suggests that dust from some slags may be a health problem requiring worker protection.²² On the other hand, the dust produced by roof cutting may contain asbestos, and dust from coal tar pitch causes skin and eye irritation similar to that resulting from exposure to volatile pitch emissions.²²

The NIOSH has identified the following controls for dust exposures. Engineering controls for dust problems include

wetting the roof, using power tools equipped with water spray and/or power tools fitted with suction devices and filters to capture the dust at the point of generation. If engineering controls are not sufficient to protect workers, NIOSH recommends the use of respirators to prevent dust inhalation, and gloves/coveralls and face shields/goggles to protect against skin and eye irritation. It should be cautioned, however, that respirators and face shields/goggles are not mandated by OSHA, and may restrict vision and contribute to falls and heat stress.

7.1.2 Falls

Slightly more than 5 percent of workers' compensation claims (in terms of incidents) for roofers reported to the CNA Insurance Company in fiscal 1992 (June-May) were from falls.²³ CNA is the largest insurer of roofing contractors in the U.S., insuring some 1800 roofing companies in over 35 states.¹⁵ These claims include falls from ladders, scaffolds, and vehicles, and to lower levels. Several Federal rules have been promulgated by OSHA to prevent workers from falling. These rules, enforced by OSHA, are contained in Subparts L and M of 29 CFR 1926 and apply to ladders and scaffolding, roof openings, and perimeter guarding.

7.1.3 Heat

Extremes of heat can place additional physiological stress on the roof removal worker. When heat exposures exceed the body's capacity to cope, heat illness results. The most dangerous heat illness is heat stroke, which occurs when the body temperature exceeds 104 °F. If the body temperature is not reduced promptly, permanent damage to the nervous system or death may result. In heat exhaustion, the individual collapses due to an insufficient supply of blood to the brain, which in turn results from vasodilation and low arterial blood pressure. Heat cramps--a less serious but nonetheless painful condition--results from an excessive loss of sodium chloride through perspiration.^{24,25}

Preventing heat illness involves reducing the time spent in the heat, using tools to reduce the metabolic demands of roof removals, having supervisors trained to recognize early signs of heat illness, and drinking adequate amounts of cool potable water.²⁵

7.1.4 Rushed Jobs

Rushing roof removal work to take advantage of favorable weather and/or to increase worker productivity can contribute to roofing injuries. For example, in the rush to complete a removal, protective equipment may not be cleaned or may not be used, perimeter protection and guarding of roof holes may be inadequate or overlooked, ladders may not be tied off, the risk of heat stress under unfavorable temperature, humidity, and wind conditions may be increased, and inexperienced and untrained workers pressed into service may behave in an unsafe manner.²²

7.2 NESHAP RELATED

The asbestos NESHAP may require wetting when RB roof cutters are used to cut roofs.

7.2.1 Safety Hazards

Under certain circumstances, wetting, as may be required by the NESHAP, could create a safety hazard. Water on a roof membrane may cause it to become slick, increasing the potential for falls and, if the water freezes during cold weather work, an even greater slippage problem is created.²⁶

The wetting required by the NESHAP can be accomplished through use of a blade guard fitted with a nozzle which applies a fine water spray on an area approximately 2 in. on either side of the cut. Thus, only a very small portion of the entire roof is wetted. On an aggregate surfaced roof, any reduction in traction due to a wet surface would be minimal, since the aggregate provides additional traction. The NESHAP does provide for exceptions from the wetting requirement where the Administrator has determined that wetting would present a safety hazard or when the temperature is below freezing at the point of removal (40 CFR 61.145(c)).

7.2.2 Property Damage

There is concern that wetting along the cut lines will allow water to penetrate beneath the roof, risking damage to the building structure and its contents.²⁷ Another problem that has been mentioned is that of wetting decks or causing work delays, since roof membranes cannot be applied to wet decks. It is possible to lightly wet a roof during removal, to hold down airborne contaminants, without water problems.²⁸ Water passing through the cut in the membrane would probably be absorbed by the underlying insulation. Since insulation is usually removed and disposed of along with the old roof membrane, problems due to wetting would be minimized. The NESHAP provides for exceptions from the wetting requirement where the Administrator has determined that wetting would unavoidably damage equipment (40 CFR 61.145(c)).

8.0 NESHAP REQUIREMENTS: INTERPRETIVE RULE GOVERNING ROOF REMOVAL OPERATIONS

The EPA has published, as a new Appendix A to Subpart M of 40 C.F.R. Part 61, an interpretive rule, which is presented in its entirety below. The purpose of the interpretive rule is to clarify the Asbestos NESHAP as it affects roof removal operations by: (i) specifying which roof removal operations EPA construes the NESHAP to cover; and (ii) specifying roof removal work practices that EPA deems to be in compliance with the NESHAP in roofing operations where the NESHAP applies.

The interpretive rule does not supersede, alter or replace the Asbestos NESHAP; nor does it change the scope or stringency of the NESHAP. Rather the interpretive rule interprets the NESHAP as it applies to roof removal operations, in order to provide particularized guidance which, if followed, would promote compliance with, and more effective and consistent enforcement of, the NESHAP in such operations.

In addition to EPA's asbestos NESHAP, other Federal regulations (e.g., OSHA) and State and local environmental and occupational safety and health regulations may apply to roofing operations. These regulations often are more stringent than EPA's asbestos NESHAP. Roofing contractors, abatement contractors, and consultants on roofing jobs involving the removal of roofing should be familiar with all applicable Federal, State, and local regulations in addition to the NESHAP.

INTERPRETIVE RULE GOVERNING ROOF REMOVAL OPERATIONS

(Appendix A, 40 CFR Part 61, Subpart M)

I. Applicability of the Asbestos NESHAP

1.1. Asbestos-containing material (ACM) is material containing more than one percent asbestos as determined using the methods specified in appendix A, subpart F, 40 C.F.R. part 763, section 1, Polarized Light Microscopy. The NESHAP classifies ACM as either "friable" or "nonfriable". Friable ACM is ACM that, when dry, can be crumbled, pulverized or reduced to powder by hand pressure. Nonfriable ACM is ACM that, when dry, cannot be crumbled, pulverized or reduced to powder by hand pressure.

1.2. Nonfriable ACM is further classified as either Category I ACM or Category II ACM. Category I ACM and Category II ACM are distinguished from each other by their potential to release fibers when damaged. Category I ACM includes asbestos-containing gaskets, packings, resilient floor coverings, resilient floor covering mastic, and asphalt roofing products containing more than one percent asbestos. Asphalt roofing products which may contain asbestos include built-up roofing; asphalt-containing single ply membrane systems; asphalt shingles; asphalt-containing underlayment felts; asphalt-containing roof coatings and mastics; and asphalt-containing base flashings. ACM roofing products that use other bituminous or resinous binders (such as coal tars or pitches) are also considered to be Category I ACM. Category II ACM includes all other nonfriable ACM, for example, asbestos-cement (A/C) shingles, A/C tiles, and transite boards or panels containing more than one percent asbestos. Generally speaking, Category II ACM is more likely to become friable when damaged than is Category I ACM. The applicability of the NESHAP to Category I and II ACM depends on: (1) the condition of the material at the time of demolition or renovation, (2) the nature of the operation to

which the material will be subjected, (3) the amount of ACM involved.

1.3. Asbestos-containing material regulated under the NESHAP is referred to as "regulated asbestos-containing material" (RACM). RACM is defined in § 61.141 of the NESHAP and includes: (1) friable asbestos-containing material; (2) Category I nonfriable ACM that has become friable; (3) Category I nonfriable ACM that has been or will be sanded, ground, cut, or abraded; or (4) Category II nonfriable ACM that has already been or is likely to become crumbled, pulverized, or reduced to powder. If the coverage threshold for RACM is met or exceeded in a renovation or demolition operation, then all friable ACM in the operation, and in certain situations, nonfriable ACM in the operation, are subject to the NESHAP.

A. Threshold Amounts of Asbestos-Containing Roofing Material

1.A.1. The NESHAP does not cover roofing projects on single family homes or on residential buildings containing four or fewer dwelling units. 40 C.F.R. § 61.141. For other roofing renovation projects, if the total asbestos-containing roof area undergoing renovation is less than 160 ft², the NESHAP does not apply, regardless of the removal method to be used, the type of material (Category I or II), or its condition (friable versus nonfriable). 40 C.F.R. §61.145(a)(4). However, EPA would recommend the use of methods that damage asbestos-containing roofing material as little as possible. EPA has determined that where a rotating blade (RB) roof cutter or equipment that similarly damages the roofing material is used to remove Category I nonfriable asbestos-containing roofing material, the removal of 5580 ft² of that material will create 160 ft² of RACM. For the purposes of this interpretive rule, "RB roof cutter" means an engine-powered roof cutting machine with one or more rotating cutting blades the edges of which are blunt. (Equipment with

blades having sharp or tapered edges, and/or which does not use a rotating blade, is used for "slicing" rather than "cutting" the roofing material; such equipment is not included in the term "RB roof cutter".) Therefore, it is EPA's interpretation that when an RB roof cutter or equipment that similarly damages the roofing material is used to remove Category I nonfriable asbestos-containing roofing material, any project that is 5580 ft² or greater is subject to the NESHAP; conversely, it is EPA's interpretation that when an RB roof cutter or equipment that similarly damages the roofing material is used to remove Category I nonfriable asbestos-containing roofing material in a roof removal project that is less than 5580 ft², the project is not subject to the NESHAP, except that notification is always required for demolitions. EPA further construes the NESHAP to mean that if slicing or other methods that do not sand, grind, cut or abrade will be used on Category I nonfriable ACM, the NESHAP does not apply, regardless of the area of roof to be removed.

1.A.2. For asbestos cement (A/C) shingles (or other Category II roofing material), if the area of the roofing material to be removed is at least 160 ft² and the removal methods will crumble, pulverize, reduce to powder, or contaminate with RACM (from other ACM that has been crumbled, pulverized or reduced to powder) 160 ft² or more of such roofing material, the removal is subject to the NESHAP. Conversely, if the area of the A/C shingles (or other Category II roofing materials) to be removed is less than 160 ft², the removal is not subject to the NESHAP regardless of the removal method used, except that notification is always required for demolitions. 40 C.F.R. § 61.145(a). However, EPA would recommend the use of methods that damage asbestos-containing roofing material as little as possible. If A/C shingles (or other Category II roofing materials) are removed without 160 ft² or more of such roofing material being crumbled, pulverized, reduced to powder, or contaminated with

RACM (from other ACM that has been crumbled, pulverized or reduced to powder), the operation is not subject to the NESHAP, even where the total area of the roofing material to be removed exceeds 160 ft²; provided, however, that if the renovation includes other operations involving RACM, the roof removal operation is covered if the total area of RACM from all renovation activities exceeds 160ft². See the definition of regulated asbestos-containing material (RACM), 40 C.F.R. § 61.141.

1.A.3. Only roofing material that meets the definition of ACM can qualify as RACM subject to the NESHAP. Therefore, to determine if a removal operation that meets or exceeds the coverage threshold is subject to the NESHAP, any suspect roofing material (i.e. roofing material that may be ACM) should be tested for asbestos. If any such roofing material contains more than one percent asbestos and if the removal operation is covered by the NESHAP, then EPA must be notified and the work practices in § 61.145(c) must be followed. In EPA's view, if a removal operation involves at least the threshold level of suspect material, a roofing contractor may choose not to test for asbestos if the contractor follows the notification and work practice requirements of the NESHAP.

B. A/C Shingle Removal (Category II ACM Removal)

1.B.1. A/C shingles, which are Category II nonfriable ACM, become regulated ACM if the material has a high probability of becoming or has become crumbled, pulverized or reduced to powder by the forces expected to act on the material in the course of demolition or renovation operations. 40 C.F.R. § 61.141. However, merely breaking an A/C shingle (or any other category II ACM) that is not friable may not necessarily cause the material to become RACM. A/C shingles are typically nailed to buildings on which they are attached. EPA believes that the extent of breakage that will normally

result from carefully removing A/C shingles and lowering the shingles to the ground will not result in crumbling, pulverizing or reducing the shingles to powder. Conversely, the extent of breakage that will normally occur if the A/C shingles are dropped from a building or scraped off of a building with heavy machinery would cause the shingles to become RACM. EPA therefore construes the NESHAP to mean that the removal of A/C shingles that are not friable, using methods that do not crumble, pulverize, or reduce the A/C shingles to powder (such as pry bars, spud bars and shovels to carefully pry the material), is not subject to the NESHAP provided that the A/C shingles are properly handled during and after removal, as discussed in this paragraph and the asbestos NESHAP. This interpretation also applies to other Category II nonfriable asbestos-containing roofing materials.

C. Cutting vs. Slicing and Manual Methods for Removal of Category I ACM

1.C.1. Because of damage to the roofing material, and the potential for fiber release, roof removal operations using rotating blade (RB) roof cutters or other equipment that sand, grind, cut or abrade the roof material are subject to the NESHAP. As EPA interprets the NESHAP, the use of certain manual methods (using equipment such as axes, hatchets, or knives, spud bars, pry bars, and shovels, but not saws) or methods that slice, shear, or punch (using equipment such as a power slicer or power plow) does not constitute "cutting, sanding, grinding or abrading." This is because these methods do not destroy the structural matrix or integrity of the material such that the material is crumbled, pulverized or reduced to powder. Hence, it is EPA's interpretation that when such methods are used, assuming the roof material is not friable, the removal operation is not subject to the regulation.

1.C.2. Power removers or power tear-off machines are typically used to pry the roofing material up from the deck after the roof membrane has been cut. It is EPA's interpretation that when these machines are used to pry roofing material up, their use is not regulated by the NESHAP.

1.C.3. As noted previously, the NESHAP only applies to the removal of asbestos-containing roofing materials. Thus, the NESHAP does not apply to the use of RB cutters to remove non-asbestos built up roofing (BUR). On roofs containing some asbestos-containing and some non-asbestos containing materials, coverage under the NESHAP depends on the methods used to remove each type of material in addition to other coverage thresholds specified above. For example, it is not uncommon for existing roofs to be made of non-asbestos BUR and base flashings that do contain asbestos. In that situation, EPA construes the NESHAP to be inapplicable to the removal of the non-asbestos BUR using an RB cutter so long as the RB cutter is not used to cut 5580 ft² or more of the asbestos-containing base flashing or other asbestos-containing material into sections. In addition, the use of methods that slice, shear, punch or pry could then be used to remove the asbestos flashings and not trigger coverage under the NESHAP.

II. Notification

2.1. Notification for a demolition is always required under the NESHAP. However, EPA believes that few roof removal jobs constitute "demolitions" as defined in the NESHAP (§ 61.141). In particular, it is EPA's view that the removal of roofing systems (i.e., the roof membrane, insulation, surfacing, coatings, flashings, mastic, shingles, and felt underlayment), when such removal is not a part of a demolition project, constitutes a "renovation" under the NESHAP. If the operation is a renovation, and Category I roofing material is

being removed using either manual methods or slicing, notification is not required by the NESHAP. If Category II material is not friable and will be removed without crumbling, pulverizing, or reducing it to powder, no notification is required. Also, if the renovation involves less than the threshold area for applicability as discussed above, then no notification is required. However, if a roof removal meets the applicability and threshold requirements under the NESHAP, then EPA (or the delegated agency) must be notified in advance of the removal in accordance with the requirements of § 61.145(b), as follows:

- Notification must be given in writing at least 10 working days in advance and must include the information in § 61.145(b)(4), except for emergency renovations as discussed below.

- The notice must be updated as necessary, including, for example, when the amount of asbestos-containing roofing material reported changes by 20 percent or more.

- EPA must be notified if the start date of the roof removal changes. If the start date of a roof removal project is changed to an earlier date, EPA must be provided with a written notice of the new start date at least 10 working days in advance. If the start date changes to a later date, EPA must be notified by telephone as soon as possible before the original start date and a written notice must be sent as soon as possible.

- For emergency renovations (as defined in § 61.141), where work must begin immediately to avoid safety or public health hazards, equipment damage, or unreasonable financial burden, the notification must be postmarked or delivered to EPA as soon as possible, but no later than the following work day.

III. Emission Control Practices

A. Requirements to Adequately Wet and Discharge No Visible Emission

3.A.1. The principal controls contained in the NESHAP for removal operations include requirements that the affected material be adequately wetted, and that asbestos waste be handled, collected, and disposed of properly. The requirements for disposal of waste materials are discussed separately in section IV below. The emission control requirements discussed in this section III apply only to roof removal operations that are covered by the NESHAP as set forth in Section I above.

3.A.2. For any operation subject to the NESHAP, the regulation (§§ 61.145(c)(2)(i), (3), (6)(i)) requires that RACM be adequately wet (as defined in § 61.141) during the operation that damages or disturbs the asbestos material until collected for disposal.

3.A.3. When using an RB roof cutter (or any other method that sands, grinds, cuts or abrades the roofing material) to remove Category I asbestos-containing roofing material, the emission control requirements of § 61.145(c) apply as discussed in Section I above. EPA will consider a roof removal project to be in compliance with the "adequately wet" and "discharge no visible emission" requirements of the NESHAP if the RB roof cutter is equipped and operated with the following: (1) a blade guard that completely encloses the blade and extends down close to the roof surface; and (2) a device for spraying a fine mist of water inside the blade guard, and which device is in operation during the cutting of the roof.

B. Exemptions from Wetting Requirements

3.B.1. The NESHAP provides that, in certain instances, wetting may not be required during the cutting of Category I asbestos roofing material with an RB roof cutter. If EPA determines in accordance with § 61.145(c)(3)(i), that wetting will unavoidably damage the building, equipment inside the building, or will present a safety hazard while stripping the ACM from a facility component that remains in place, the roof removal operation will be exempted from the requirement to wet during cutting. EPA must have sufficient written information on which to base such a decision. Before proceeding with a dry removal, the contractor must have received EPA's written approval. Such exemptions will be made on a case-by-case basis.

3.B.2. It is EPA's view that, in most instances, exemptions from the wetting requirements are not necessary. Where EPA grants an exemption from wetting because of the potential for damage to the building, damage to equipment within the building or a safety hazard, the NESHAP specifies alternative control methods (§ 61.145(c)(3)(i)(B)). Alternative control methods include (a) the use of local exhaust ventilation systems that capture the dust, and do not produce visible emissions, or (b) methods that are designed and operated in accordance with the requirements of § 61.152, or (c) other methods that have received the written approval of EPA. EPA will consider an alternative emission control method in compliance with the NESHAP if the method has received written approval from EPA and the method is being implemented consistent with the approved procedures (§ 61.145(c)(3)(ii) or § 61.152(b)(3)).

3.B.3. An exemption from wetting is also allowed when the air or roof surface temperature at the point of wetting is below freezing, as specified in § 61.145(c)(7). If freezing

temperatures are indicated as the reason for not wetting, records must be kept of the temperature at the beginning, middle and end of the day on which wetting is not performed and the records of temperature must be retained for at least 2 years. 42 C.F.R. § 61.145(c)(7)(iii). It is EPA's interpretation that in such cases, no written application to, or written approval by the Administrator is needed for using emission control methods listed in § 61.145(c)(3)(i)(B), or alternative emission control methods that have been previously approved by the Administrator. However, such written application or approval is required for alternative emission control methods that have not been previously approved. Any dust and debris collected from cutting must still be kept wet and placed in containers. All of the other requirements for notification and waste disposal would continue to apply as described elsewhere in this notice and the Asbestos NESHAP.

C. Waste Collection and Handling

3.C.1. It is EPA's interpretation that waste resulting from slicing and other methods that do not cut, grind, sand or abrade Category I nonfriable asbestos-containing roofing material is not subject to the NESHAP and can be disposed of as nonasbestos waste. EPA further construes the NESHAP to provide that if Category II roofing material (such as A/C shingles) is removed and disposed of without crumbling, pulverizing, or reducing it to powder, the waste from the removal is not subject to the NESHAP waste disposal requirements. EPA also interprets the NESHAP to be inapplicable to waste resulting from roof removal operations that do not meet or exceed the coverage thresholds described in section I above. Of course, other State, local, or Federal regulations may apply.

3.C.2. It is EPA's interpretation that when an RB roof cutter, or other method that similarly damages the roofing

material, is used to cut Category I asbestos containing roofing material, the damaged material from the cut (the sawdust or debris) is considered asbestos containing waste subject to § 61.150 of the NESHAP, provided the coverage thresholds discussed above in section 1 are met or exceeded. This sawdust or debris must be disposed of at a disposal site operated in accordance with the NESHAP. It is also EPA's interpretation of the NESHAP that if the remainder of the roof is free of the sawdust and debris generated by the cutting, or if such sawdust or debris is collected as discussed below in paragraphs 3.C.3, 3.C.4, 3.C.5 and 3.C.6, the remainder of the roof can be disposed of as nonasbestos waste because it is considered to be Category I nonfriable material (as long as the remainder of the roof is in fact nonasbestos material or if it is Category I asbestos material and the removal methods do not further sand, grind, cut or abrade the roof material). EPA further believes that if the roof is not cleaned of such sawdust or debris, i.e., it is contaminated, then it must be treated as asbestos-containing waste material and be handled in accordance with § 61.150.

3.C.3. In order to be in compliance with the NESHAP while using an RB roof cutter (or device that similarly damages the roofing material) to cut Category I asbestos containing roofing material, the dust and debris resulting from the cutting of the roof should be collected as soon as possible after the cutting operation, and kept wet until collected and placed in leak-tight containers. EPA believes that where the blade guard completely encloses the blade and extends down close to the roof surface and is equipped with a device for spraying a fine mist of water inside the blade guard, and the spraying device is in operation during the cutting, most of the dust and debris from cutting will be confined along the cut. The most efficient methods to collect the dust and debris from cutting are to immediately collect or vacuum up the damaged material where it lies along the cut

using a filtered vacuum cleaner or debris collector that meets the requirements of 40 C.F.R. § 61.152 to clean up as much of the debris as possible, or to gently sweep up the bulk of the debris, and then use a filtered vacuum cleaner that meets the requirements of 40 C.F.R. § 61.152 to clean up as much of the remainder of the debris as possible. On smooth surfaced roofs (nonaggregate roofs), sweeping up the debris and then wet wiping the surface may be done in place of using a filtered vacuum cleaner. It is EPA's view that if these decontamination procedures are followed, the remaining roofing material does not have to be collected and disposed of as asbestos waste. Additionally, it is EPA's view that where such decontamination procedures are followed, if the remaining portions of the roof are non-asbestos or Category I nonfriable asbestos material, and if the remaining portions are removed using removal methods that slice, shear, punch or pry, as discussed in section 1.C above, then the remaining portions do not have to be collected and disposed of as asbestos waste and the NESHAP's no visible emissions and adequately wet requirements are not applicable to the removal of the remaining portions. In EPA's interpretation, the failure of a filtered vacuum cleaner or debris collector to collect larger chunks or pieces of damaged roofing material created by the RB roof cutter does not require the remaining roofing material to be handled and disposed of as asbestos waste, provided that such visible chunks or pieces of roofing material are collected (e.g. by gentle sweeping) and disposed of as asbestos waste. Other methods of decontamination may not be adequate, and should be approved by the local delegated agency.

3.C.4. In EPA's interpretation, if the debris from the cutting is not collected immediately, it will be necessary to lightly mist the dust or debris, until it is collected, as discussed above, and placed in containers. The dust or debris should be lightly misted frequently enough to prevent the

material from drying, and to prevent airborne emissions, prior to collection as described above. It is EPA's interpretation of the NESHAP that if these procedures are followed, the remaining roofing material does not have to be collected and disposed of as asbestos waste, as long as the remaining roof material is in fact nonasbestos material or if it is Category I asbestos material and the removal methods do not further sand, grind, cut or abrade the roof material.

3.C.5. It is EPA's interpretation that, provided the roofing material is not friable prior to the cutting operation, and provided the roofing material has not been made friable by the cutting operation, the appearance of rough, jagged or damaged edges on the remaining roofing material, due to the use of an RB roof cutter, does not require that such remaining roofing material be handled and disposed of as asbestos waste. In addition, it is also EPA's interpretation that if the sawdust or debris generated by the use of an RB roof cutter has been collected as discussed in paragraphs 3.C.3, 3.C.4 and 3.C.6, the presence of dust along the edge of the remaining roof material does not render such material "friable" for purposes of this interpretive rule or the NESHAP, provided the roofing material is not friable prior to the cutting operation, and provided that the remaining roofing material near the cutline has not been made friable by the cutting operation. Where roofing material near the cutline has been made friable by the use of the RB cutter (i.e. where such remaining roofing material near the cutline can be crumbled, pulverized or reduced to powder using hand pressure), it is EPA's interpretation that the use of an encapsulant will ensure that such friable material need not be treated or disposed of as asbestos containing waste material. The encapsulant may be applied to the friable material after the roofing material has been collected into stacks for subsequent disposal as nonasbestos waste. It is EPA's view that if the encapsulation procedure set forth in this

paragraph is followed in operations where roofing material near the cutline has been rendered friable by the use of an RB roof cutter, and if the decontamination procedures set forth in paragraph 3.C.3 have been followed, the NESHAP's no visible emissions and adequately wet requirements would be met for the removal, handling and disposal of the remaining roofing material.

3.C.6. As one way to comply with the NESHAP, the dust and debris from cutting can be placed in leak-tight containers, such as plastic bags, and the containers labeled using warning labels required by OSHA (29 CFR 1926.58). In addition, the containers must have labels that identify the waste generator (such as the name of the roofing contractor, abatement contractor, and/or building owner or operator) and the location of the site at which the waste was generated.

IV. Waste Disposal

A. Disposal Requirements

4.A.1. Section 61.150(b) requires that, as soon as is practical, all collected dust and debris from cutting as well as any contaminated roofing squares, must be taken to a landfill that is operated in accordance with § 61.154 or to an EPA-approved site that converts asbestos waste to nonasbestos material in accordance with § 61.155. During the loading and unloading of affected waste, asbestos warning signs must be affixed to the vehicles.

B. Waste Shipment Record

4.B.1. For each load of asbestos waste that is regulated under the NESHAP, a waste shipment record (WSR) must be maintained in accordance with § 61.150(d). Information that must be maintained for each waste load includes the following:

- Name, address, and telephone number of the waste generator

- Name and address of the local, State, or EPA regional office responsible for administering the asbestos NESHAP program

- Quantity of waste in cubic meters (or cubic yards)

- Name and telephone number of the disposal site operator

- Name and physical site location of the disposal site

- Date transported

- Name, address, and telephone number of the transporter(s)

- Certification that the contents meet all government regulations for transport by highways.

4.B.2. The waste generator is responsible for ensuring that a copy of the WSR is delivered to the disposal site along with the waste shipment. If a copy of the WSR signed by the disposal site operator is not returned to the waste generator within 35 days, the waste generator must contact the transporter and/or the disposal site to determine the status of the waste shipment. 40 C.F.R. § 61.150(d)(3). If the signed WSR is not received within 45 days, the waste generator must report, in writing, to the responsible NESHAP program agency and send along a copy of the WSR. 40 C.F.R. § 61.150(d)(4). Copies of WSRs, including those signed by the disposal site operator, must be retained for at least 2 years. 40 C.F.R. § 61.150(d)(5).

V. Training

5.1. For those roof removals that are subject to the NESHAP, at least one on-site supervisor trained in the provisions of the NESHAP must be present during the removal of the asbestos roofing material. 40 C.F.R. § 61.145(c)(8). In EPA's view, this person can be a job foreman, a hired consultant, or someone who can represent the building owner or

contractor responsible for the removal. In addition to the initial training requirement, a refresher training course is required every 2 years. The NESHAP training requirements became effective on November 20, 1991.

5.2. Asbestos training courses developed specifically to address compliance with the NESHAP in roofing work, as well as courses developed for other purposes can satisfy this requirement of the NESHAP, as long as the course covers the areas specified in the regulation. EPA believes that Asbestos Hazard Emergency Response Act (AHERA) training courses will, for example, satisfy the NESHAP training requirements. However, nothing in this interpretive rule or in the NESHAP shall be deemed to require that roofing contractors or roofing workers performing operations covered by the NESHAP must be trained or accredited under AHERA, as amended by the Asbestos School Hazard Abatement Reauthorization Act (ASHARA). Likewise, state or local authorities may independently impose additional training, licensing, or accreditation requirements on roofing contractors performing operations covered by the NESHAP, but such additional training, licensing or accreditation is not called for by this interpretive rule or the federal NESHAP.

5.3. For removal of Category I asbestos containing roofing material where RB roof cutters or equipment that similarly damages the asbestos-containing roofing material are used, the NESHAP training requirements (§ 61.145(c)(8)) apply as discussed in Section I above. It is EPA's intention that removal of Category I asbestos-containing roofing material using hatchets, axes, knives, and/or the use of spud bars, pry bars and shovels to lift the roofing material, or similar removal methods that slice, punch, or shear the roof membrane are not subject to the training requirements, since these methods do not cause the roof removal to be subject to the NESHAP. Likewise, it is EPA's intention that roof removal

operations involving Category II nonfriable ACM are not subject to the training requirements where such operations are not subject to the NESHAP as discussed in section I above.

REFERENCES

1. Census of Construction Industries, 1987. INDUSTRY SERIES CC87-1-18: Roofing, Siding, and Sheet Metal Work Special Trade Contractors. U.S. Government Printing Office, Washington, D.C., January 1990.
2. Letter from W. A. Good, National Roofing Contractors Association, to J. W. Rasnic, U.S. Environmental Protection Agency, March 7, 1991.
3. Annual Market Survey, 1992-1993, National Roofing Contractors Association.
4. National Roofing Contractors Association. The NRCA Roofing and Waterproofing Manual. Third Edition. Rosemont, IL: 1992.
5. Griffin, C. W., Manual of Built-up Roof Systems, 2d Ed. New York: McGraw-Hill Book Company, 1982.
6. National Roofing Contractors Association, 1991/1992 NRCA Market Survey.
7. Herbert, R. D. III, Roofing Design Criteria, Options, Selection. Kingston, MA: R.S. Means Company, Inc., 1989.
8. Watson, J. A., Roofing Systems: Materials and Application. Reston, VA: Reston Publishing Co., Inc., 1979.
9. Andersen, P. H., M. A. Grant, R. G. McInnes, and W. J. Farino, Analysis of Fiber Release from Certain Asbestos Products, Draft Final Report, GCA-TR-82-53-G. Bedford, MA: GCA Corporation, December 1982.
10. The Roofing Industry Educational Institute. Englewood, CO., n.d.
11. Asbestos Containing Portland Cement Binder Products, R-358. Englewood, CO: The Roofing Industry Educational Institute, May 1989.
12. Telecon. M. Laney with R. Girouard and R. Shafer, R. K. Hydro-Vac, Inc., Charlotte, NC. August 7 and 22, 1991.
13. Trip Report. Martin Roofing Co., Inc., Wichita, KS. July 10, 1991.

14. Trip Report. Lloyd Roofing Co., Inc., Beech Island, SC. June 11, 1991.
15. Letter from W. A. Good, National Roofing Contractors Association, to S. Roy, U.S. Environmental Protection Agency, November 2, 1993.
16. Telecon. M. Laney with L. Biggers, Young Sales Co., Inc., Louisville, KY. June 18, 1991.
17. EDCO-Equipment Development Co. Product brochure. n.d.
18. Telecon. M. Laney with D. Wiggins and R. Nixon, HDH Associates, P.C., Salem, VA. September 5, 1991.
19. Trip report, Young Sales Co., Inc. Louisville, KY. July 25, 1991.
20. The School District of Greenville County, South Carolina. Roofing ACM. Study: Simulating Roofing ACM Removal and A Protocol: Identifying ACM in School Roofing. May 10, 1987.
21. Trip report, Clean Waste, Incorporated, Adams, MA. August 27, 1991.
22. Health and Safety Guide for the Commercial Roofing Industry, DHEW (NIOSH) Publication. No. 78-194. Cincinnati: U.S. Department of Health, Education, and Welfare, National Institute for Occupational Safety and Health, September 1978.
23. Unpublished CNA Insurance Claim Data, 1988-1991.
24. Lee, D. H. K., Heat and Cold Effects and Their Control, Public Health Monograph No. 72, Public Health Service Publication No. 1084. Washington, D.C.: U.S. Government Printing Office, 1964.
25. U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, Criteria for a Recommended Standard...Occupational Exposure to Hot Environments, Revised Criteria 1986. Washington, D.C.: U.S. Government Printing Office, April 1986.
26. Memorandum from Tom Smith, National Roofing Contractors Association to Carl Good, National Roofing Contractors Association, January 23, 1991, Attachment B to Letter from William A. Good, National Roofing Contractors Association to William P. Reilly, U.S. Environmental Protection Agency, January 26, 1991.

27. Letter from William A. Good, National Roofing Contractors Association to William P. Reilly, U.S. Environmental Protection Agency, January 26, 1991.
28. Asbestos in Roofing: Work Practices and Disposal, R-391. Englewood, CO: The Roofing Industry Educational Institute, 1988.

APPENDIX A
GLOSSARY

Aggregate: Crushed stone, crushed slag, or water-worn gravel used for surfacing a built-up roof; any granular mineral material.

Alligatoring: The cracking of the surfacing bitumen on a built-up roof, producing a pattern of cracks similar to a alligator's hide; the cracks may or may not extend through the surfacing bitumen.

Asphalt: A dark brown to black cementitious material in which the predominating constituents are bitumens, which occur in nature or are obtained in petroleum processing.

Asphalt, Air Blown: An asphalt produced by blowing air through molten asphalt at an elevated temperature to raise its softening point and modify other properties.

Asphalt Felt: An asphalt-saturated felt.

Base Ply: The base ply is the first ply when it is a separate ply and not part of a shingled system.

Base Sheet: A saturated or coated felt placed as the first ply in some multiply, built-up membranes.

Bitumen: The generic term for an amorphous, semi-solid mixture of complex hydrocarbons derived from any organic source. Asphalt and coal tar are the two bitumens used in the roofing industry.

Blind Nailing: The practice of nailing the back portion of a ply.

Blister: A spongy raised portion of a roof membrane, ranging in area from one inch in diameter and of barely detectable height upwards. Blisters result from the pressure build-up of gases entrapped in the membrane system. The gases most commonly are air/or water vapor. Blisters usually involve delamination of the underlying membrane plies.

Brooming: Embedding a ply of roofing material by using a broom to smooth out the ply and ensure contact with the adhesive under the ply.

Built-up Roof Membrane: A continuous roof covering of laminations, or plies, of saturated or coated felts alternated with layers of bitumen, surfaced with mineral aggregate or asphalt.

BUR: Abbreviation sometimes used for built-up roofing membrane.

Cap Sheet: A granule-surfaced coated sheet used for the top ply of a built-up roof membrane or flashing.

Coal Tar Bitumen: A dark brown to black, semi-solid hydrocarbon formed as a residue from the partial evaporation or distillation of coal tar. It is used as the waterproofing agent in dead-level or low slope built-up roofs. It differs from Coal Tar Pitch in having a lower front-end volatility.

Coal Tar Pitch: A dark brown to black semi-solid hydrocarbon formed as a residue from the partial evaporation or distillation of coal tar. It is used as the waterproofing agent in dead-level or low-slope built-up roofs.

Coated Base Sheet: A felt that has previously been "saturated" (impregnated with asphalt) and later coated with harder, more viscous asphalt, which greatly increases its impermeability to moisture.

Cold-Process Roofing: A continuous semi-flexible roof membrane, consisting of plies of felts, mats, or fabrics that are laminated on a roof with alternate layers of cold-applied roof cement and surfaced with a cold-applied coating.

Counterflashing: Formed metal or elastomeric sheeting secured on or into a wall, curb, pipe, rooftop unit or other surface to cover and protect the upper edge of a base flashing and its associated fasteners.

Cutback: Any bituminous roofing material that has been solvent thinned. Cutbacks are used in cold-process roofing adhesives, flashing cements, and roof coating.

Dead-level: Absolutely horizontal, or zero slope.

Dead-level Asphalt: A roofing asphalt that has a softening point of 140 °F. (60°C) and that conforms to the requirements of ASTM Standard D 312, Type 1.

Dead Loads: Non-moving roof top loads, such as mechanical equipment, air conditioning units, and the roof deck itself.

Deck: The structural surface to which the roofing or water-proofing system (including insulation) is applied.

EPDM: Ethylene Propylene Diene Monomer.

Felt: A fabric manufactured by the interlocking of fibers through a combination of mechanical work, moisture, and heat without spinning, weaving or knitting. Roofing felts are manufactured from vegetable fibers, asbestos fibers or glass fibers.

Fishmouth: An opening formed by an edge wrinkle in a felt where it overlaps another felt in a built-up roofing membrane.

Flashing: The system used to seal the edges of a membrane at walls, expansion joints, drains, gravel stops, and other areas where the membrane is interrupted or terminated. Base flashing covers the edges of the membrane. Cap flashing or counter-flashing shields the upper edges of the base flashing.

Flat Asphalt: A roofing asphalt that has a softening point of approximately 170°F. (77°C) and that conforms to the requirements of ASTM Standard D 312, Type II.

Flood Coat: The top layer of bitumen in an aggregate surface, built-up roofing membrane. Correctly applied, it is poured, not mopped, to a weight of 60 pounds per square for asphalt, 75 pounds per square for coal-tar pitch.

Fluid Applied Elastomer: An elastomeric material, which is fluid at ambient temperatures, that dries or cures after application to form a continuous membrane.

Glass Fiber Felt: A felt sheet in which glass fibers are bonded into the felt sheet with resin. They are suitable for impregnation and coating. They are used in the manufacture and coating of bituminous waterproofing materials, roof membranes and shingles.

Hypalon: A synthetic rubber (chemically chlorosulfonated polyethylene), often used in conjunction with neoprene in elastomeric roof coverings.

Inorganic: Being or composed of matter other than hydrocarbons and their derivatives, or matter that is not of plant or animal origin.

Insulation: A material applied to reduce the flow of heat.

Membrane: A flexible or semi-flexible roof covering or waterproofing layer, whose primary function is the exclusion of water.

Metal Flashing: See Flashing; metal flashing is frequently used as through-wall flashing, cap flashing, counterflashing or gravel stops.

Mineral Fiber Felt: A felt with mineral wool as its principal component.

Mineral Granules: Opaque, natural or synthetically colored aggregate commonly used to surface cap sheets, granule-surfaced sheets and roofing shingles.

Mineral-Surfaced Roofing: Built-up roofing materials whose top ply consists of a granule-surfaced sheet.

Mineral-Surfaced Sheet: A felt that is coated on one or both sides with asphalt and surfaced with mineral granules.

Mopping: An application of hot bitumen applied to the substrate or to the felts of a built-up roof membrane with a mop or a mechanical applicator.

Nailing: (1) In the exposed nail method, nail heads are exposed to the weather; (2) In the concealed nail method, nail heads are concealed from the weather (see also Blind Nailing).

Neoprene: A synthetic rubber (polychloroprene) used in liquid applied and sheet applied elastomeric roof membranes or flashing.

Organic: Being or composed of hydrocarbons or their derivatives, or matter of plant or animal origin.

Perlite: An aggregate used in light-weight insulating concrete and in preformed perlitic insulation boards, formed by heating and expanding siliceous volcanic glass.

Perm: A unit of water vapor transmission defined as one (1) grain of water vapor per square foot per hour per inch of mercury pressure difference (1 inch of mercury = 0.491 psi).

Permeance: The rate of vapor transmission per unit area at a steady state through a membrane or assembly.

Pitch: (1) Roofers term as applied to coal tar bitumen. (2) The degree of slope of a roof.

Ply: A layer of felt in a built-up roof membrane system. A four-ply membrane system has four plies of felt.

PVC: Polyvinyl-chloride single-ply membrane (as applied to roofing).

Re-covering: The addition of a new membrane over a major portion of a roof surface. This may or may not involve removal of the old membrane and may not include installation of additional insulation.

Reinforced Membrane: A roofing or waterproofing membrane reinforced with felts, mats, fabrics or chopped fiber.

Reroofing: The removal of all roof system components down to the structural deck followed by installation of completely new roofing system.

Resaturant: Cold applied viscous tar or asphalt bitumen for coating roofs.

Roll Roofing: The term applied to smooth-surfaced or mineral-surfaced coated felts.

Roof System: A system of interacting roof components designed to weatherproof and normally, to insulate a building's top surface.

Saturated Felt: A felt that has been impregnated with bitumen of low softening point from 100°F to 160°F.

Shingle: (1) A small unit of prepared roofing material designed to be installed with similar units in overlapping rows on inclines normally exceeding 25%; (2) To cover with shingles; (3) To apply any sheet material in overlapping rows like shingles.

Slag: A grayish, porous aggregate left as a residue from blast furnaces and used as surfacing aggregate.

Slope: The tangent of the angle between the roof surface and the horizontal. It is measured in inches per foot.
Level slope - up to 1/2 inch per foot.
Low slope - 1/2 inch per foot to 1 1/2 inches per foot.
Steep slope - over 1 1/2 inches per foot.

Smooth Surfaced Roof: A built-up roofing membrane surfaced with a layer of hot mopped asphalt, cold-applied asphalt-clay emulsion, cold-applied asphalt cutback, or sometimes with an unmopped inorganic felt.

Softening Point: The temperature at which bitumen becomes soft enough to flow. The softening point of asphalt is measured by the "ring and ball" test (ASTM Standard D 2398). The softening point of coal tar pitch is measured by the "cube in water" test (ASTM Standard D 61).

Special Steep Asphalt: A roofing asphalt that has a softening point of approximately 220°F (104°C) and that conforms to the requirements of ASTM Standard D 312, Type IV.

Square: The term used to describe 100 square feet of roof area.

Steep Asphalt: A roofing asphalt that has a softening point of approximately 190°F (88°C) and that conforms to the requirements of ASTM Standard D 312, Type III.

Thermal Insulation: A material applied to reduce the flow of heat.

Vapor Barrier: (more precisely, vapor retarder) A layer of material used to appreciably reduce the flow of water vapor into thermal insulation from the high vapor pressure side.

Vapor Migration: The movement of water vapor from a region of high vapor pressure to a region of lower vapor pressure.

Vapor Retarder: A material designed to restrict the passage of water vapor through a wall or roof. In the roofing industry, a vapor retarder should have a perm rating of 0.5 or less.

Vermiculite: An aggregate used in lightweight insulating concrete, formed by the heating and consequent expansion of a micaceous mineral.

Waterproofing: Treatment of a surface of structure to prevent the passage of water under hydrostatic pressure.

Source: HDH Associates, P.C. Roofing Glossary. Salem, VA. n.d.

