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ANALYSIS OF FIBER RELEASE FROM CERTAIN ASBESTOS PRODUCTS

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SECTION 7

ASBESTOS PAPER PRODUCTS

OVERVIEW

Products within this category include those that contain asbestos fibers and are manufactured on a fourdrinier or cylinder papermaking machine. Several subcategories have been identified for Paper Products.[1,2] For this report, the following subcategories were investigated; roofing felt, flooring felt, millboard and rollboard, beater-add paper used for gaskets, and electrical insulating paper. Paper product subcategories not profiled include commercial paper, specialty paper, and pipeline wrap.

The manufacture of all asbestos-containing paper products is similar. Raw materials are blended together with water in a pulp beater or hollander. This base stock is then processed through a series of material build-up and dewatering steps followed by drying. Product differentiation results from the addition of a manufacturing step, such as the saturation of paper with asphalt to produce roofing felts, or from using different forming equipment, as with millboard production. Paper products are also differentiated by varying asbestos content and grades, as well as binders and fillers.[3]

ROOFING FELT

Introduction

Asbestos roofing felt is a paper product that is converted to a weather resistant roofing material by saturation of the paper with asphalt or tar. Asbestos fibers are used in the manufacture of roofing felts because they provide dimensional stability and resistance to rot, fire, and heat buildup. Rot resistance is particularly important due to roofing felt's use on flat or nearly flat surfaces having poor drainage.

Asbestos roofing felts are typically composed of 85 to 87 percent asbestos (primarily chrysotile) with differing amounts of cellulose fibers and starch binders. Sheets of roofing paper are made in either single or multilayered grades and may have fiberglass filaments or wire strands embedded between the felt layers for reinforcement.

Following formation on the papermaking machines, the paper-like product is either drawn through a bath of hot asphalt or coal tar to provide a weather resistant coating or wound into rolls for future processing. The process of applies the felt. In order to achieve a uniform membrane (referring to the total built-up layer) thickness along the edges of the roof deck, a single felt is ordinarily cut lengthwise to obtain two felt strips of the required widths to build up the perimeter thickness. These strips are generally 30, 46, and 61 cm (12, 18, and 24 inches) wide. When the felt is used as underlayment for a shingle or sheet roof, the felt is generally nailed to the deck and no asphalt coatings are used.[5]

Asbestos roofing felts have been in use for over 100 years.[9] Built-up roofs comprised of these felts are reported to have an expected service life of at least 20 years, with some lasting up to 40 years.[9,10]

Product deterioration results principally from climatic exposure. During weathering asphalt coatings and asphaltic felts become brittle and crack.[4] Where isolated leaks occur due to excessive wear, the roof may be repaired simply by application of heated asphalt or a cold-apply roof coating to the affected area. If the deterioration is widespread, the entire roof must be recovered or replaced. Since the roof membrane derives much of its integrity from the structure of overlapping felts, a number of localized repairs is much less effective than total recovering or replacement.[7]

Industry representatives report that more than 60 percent of the asbestos roofing felt produced is applied during reroofing, with the remainder used in new construction.[1] Johns-Manville representatives report that the smooth-surface type of roof is the easiest to recover and replace, owing to the smooth surface and overall light weight.[4,8] A gravel-surface roof requires at least power-brooming to prepare the surface for recovering, and frequently the top layer of gravel/asphalt must be removed entirely to provide a smooth surface.[4,8] Additionally, the gravel-surface roof is the heaviest of the three built-up roof types, and careful attention must be paid to the structural capacity of the underlying roof deck if the existing asphalt flood coat and gravel are to be left intact. Recovering tends to be preferred over reroofing because of lower costs.[8]

Roof removal generally requires chopping or sawing the existing roof membrane into pieces which can be pried or scraped off the roof deck. Any number of roof layers may be removed depending on the scope of the roofing job, from the top layer of asphalt down to the insulation or the roof deck itself. Cutting tools commonly used are an axe or circular saw (mounted on wheels), the latter being faster and generally used on large jobs.[4,11] The circular saw is preferred for removal of top layers of a membrane because it cuts to a controlled depth. After cutting, the cut-up blocks of roof are pried off of the deck or underlying layers with a shovel or crow bar.[4,11] In large job operations, the waste material is carted to the edge of the roof in wheelbarrows and is dropped down enclosed chutes leading to a ground-level dumpster. Less sophisticated disposal methods are used for smaller jobs.

A series of several scraping routines and a final sweep of the roof area may be necessary to prepare the deck for application of a new roof.[11] A Johns-Manville representative stated that it is impossible to characterize the number of workers and time required for a reroofing job, as the work and even the tools used vary widely with the roof type.[4] Removal of a 10.5 x 18 meter (35 x 60 foot) section of fiberglass-insulated asphalt roofing membrane, which was monitored by GCA/Technology Division personnel in December 1979, required about 2 hours.[11] Built-up roof installation is estimated to take a similar length of time or longer to apply the multilayered membrane.

Airborne asbestos fiber release during roofing felt installation is expected to be low. Asbestos-containing roofing felts, which are coated with asphalt, are quite pliable and normally carefully handled during built-up roof construction to ensure the integrity of the finished membrane.[7,12] During installation, the only mechanical disruption applied to the felt is cutting with a sharp bladed tool. Liberation of asbestos fibers from such a low energy activity is expected to be minimal.

In use, asbestos-containing felt is isolated from the atmosphere by layers of asphalt and/or other roof coating materials. Although these coatings may eventually wear off, wind and water erosion is believed to be a very gradual process whereby minimal fiber release is expected. By the time the felt becomes exposed, a membrane leak is likely and repairs would be performed on the affected area. Roofing materials tend to wear nonuniformly, therefore the felt is not likely to be exposed over the whole roof at one time.

Of all the roofing felt end use activities, felt removal poses the greatest potential for fiber release. During this operation the top membrane coating and the asphalt in the felt have weathered to a hard, stiff material. During removal, when surface layers are sawed and scraped, the felt matrix is likely to be physically altered, releasing free-form asbestos fibers. The membrane top coat and asphalt coats between the felt layers, however, do tend to bind the cut felts together, minimizing felt fracture during prying and waste disposal.

Airborne Fiber Monitoring Data

Several monitoring studies have been conducted to determine airborne asbestos fiber concentrations encountered during roofing felt installation and removal. Results of these studies, conducted by the Johns-Manville Corporation and GCA/Technology Division, are presented in Table 19. Airborne fiber concentrations in and around the work sites were generally found to be equal to or less than 0.6 f/cm^3.

The Johns-Manville studies were initiated through requests by internal marketing staff or roofing representatives and spanned a period from October 1972 to August 1976. Air samples collected were analyzed in Waukegan, IL, Manville, NJ, and Denver, CO by Johns-Manville technicians using the PCM analytical method.[6] The GCA samples were obtained on December 11, 1979 and were analyzed by Eastern Analytical Laboratories of Burlington, MA using SEM (5000x) and EDXR techniques.

The data presented in Table 19 do not indicate any trends as to which roofing operation has the greatest potential for airborne asbestos fiber release. Although reported fiber concentrations for any given study

TABLE 19. FIBER MONITORING DATA FROM ASBESTOS ROOFING FELT STUDIES[11,13]

Test conditions[a]	Sample No.[b] Man	Sample No.[b] Area	Specific operation or area sampled	Tools/materials	Fiber level (f/cm³)[c]
10-10-72 (5-10 mph) Univ. of Wisconsin (MD) by Nelson Roofing Co. (I)--Johns-Manville (Waukegan)	1		Majority of cutting felt; also spread asphalt	Centurian base, No. 15 finishing felts	0.3
	2		Assisted cutting and laying felt	Same as above	0.2
	3		Carried felts to operation; some cutting	Same as above	0.2
		1	Upwind of operation	---	0.1
		2	Along side operation	---	0.1
		3	Downwind of operation	---	0.1
		4	Six ft above operation	---	0.1
5-18-73 (MD) School at Hobart, IN (MD) by Maris Roofing Co. (I)--Johns-Manville (Waukegan)	1		Mopping hot asphalt	ND	0.1
	2		Laying and cutting felt	ND	0.1
	3		Hot asphalt tank operator	ND	0.2
		1	Downwind of operation	---	0.1
		2	Downwind of operation (near men shoveling scrap off roof to truck)	---	0.4
		3	Downwind of operation	---	0.1
3-14-74 (9-10 mph) at Racine, WI (2,000 sq ft) by unidentified contractor (I)--Johns-Manville (Denver)		1	Ground level 500 ft from school building (75 ft below roof)	---	0.4
		2	15 ft upwind of operation, 4 ft above roof	---	0.4
		3	Same as No. 2 area	---	0.2
		4	15 ft downwind of operation, 2 ft above roof	---	0.3
		5	30-15 ft downwind of operation, 2 ft above roof	---	0.3
	6		Mopping hot asphalt; some felt cutting and laying	Knife to cut felt/Centurian base, perforated finishing felts	0.6
	7		Cutting and laying felt	Same as above	0.5

(continued)

TABLE 19 (continued)

Test conditions[a]	Sample No.[b] Man	Sample No.[b] Area	Specific operation or area sampled	Tools/materials	Fiber level (f/cm³)[c]
4-11-74 (10 mph) School at Indianapolis, IN (1,350 sq ft) by Sink & Edwards Roofing CO. (R)--Johns-Manville (Waukegan)		1	525 ft upwind of building at ground level	—	0.3
		2	18-25 ft downwind of operation, 4-5 ft above roof	—	0.1
		3	Same as No. 2 area	—	0.2
		4	40 ft upwind of operation 4-5 ft above roof	—	0.4
	5		All phases of roof removal	Axe cutting, pry bars and shovels to remove surface; sweep clean with broom	0.1
	6		Same as No. 5 man	Same as above	0.3
5-21-74 ("slight-moderate") Dept. Store at Allentown, PA (1,500 sq ft) by Hill Metal and Roofing Co. (R,I)--Johns-Manville (Manville)	1		Power sawing and removing sections of old roofing	Power saw, pry bar	0.1
			Tacking down new felt	Nailing Centurian base felt	0.0
	2		Prying off old roofing	Pry bar	0.0
			Laying new felt (unrolling)	Centurian base felt	0.1
	3		Removing old roofing	Wheelbarrow	0.1
			Tacking down new felt	Nailing Centurian base felt	0.2
		4	Upwind corner of work area--removal	—	0.1
			- Installation	—	0.1
		5	25 ft downwind of work area--removal	—	0.1
			- Installation	—	0.1
		6	15 ft downwind of ground-level truck receiving waste roofing--removal	—	0.2
			- Installation	—	0.1
		7	150 ft downwind of work area and at ground level--removal	—	0.1
			- Installation	—	0.1

(continued)

TABLE 19 (continued)

Test conditions[a]	Sample No.[b] Man	Area	Specific operation or area sampled	Tools/materials	Fiber level (f/cm^3)[c]
5-21-74 (continued)		8	25 ft upwind of ground-level truck receiving waste roofing—removal	---	0.0
			- Installation	---	0.0
7-25-74 (0-2 mph) School at Gary, IN (3,500 sq ft) by Maris Roofing Co. (R,I)--Johns-Manville (Waukegan)	1		Roof removal by sawing, prying; installation by nailing base felt and hot mopping other layers	Power saw, shovel, wheelbarrow, broom; nailing felts, mopping hot asphalt	0.2
	2		Same as No. 1 man	Same as above	0.3
		3	15 ft downwind of work area	---	0.1
		4	15 ft upwind of work area	---	0.2
11-20-74 (18-8 mph) School at Cherry Creek, no state given (5,800 sq ft) by United Materials Roofing Co. (I)—Johns-Manville (Waukegan)		1	Upwind edge of work area	---	0.1
		2	Downwind edge of work area	---	0.1
	3		Felt laying machine operator	Machine lays felt in hot tar	0.2
	4		Broom felt into hot asphalt	Push broom	0.1
	5		Hot asphalt tank operator	Pouring hot asphalt	0.1
	6		Felt "fitting" (probable cutting)	ND	0.2
12-15-75 (variable) Industrial building no location given (7,700 sq ft) by unknown contractor (I)--Johns-Manville (Waukegan)	1		Felt laying machine operator	Machine lays felt in hot tar	<0.1
	2		Replace felt rolls on laying machine, broom felt into tar	Push broom	<0.1
		3	North edge of work area, generally upwind	---	<0.1
		4	South edge of work area, generally downwind	---	0.0
		5	East edge of work area	---	<0.1
8-76 (ND) School at Anderson, IN (1,500 sq ft) by Adams Roofing (R,I)—Johns-Manville (Waukegan)		1	2 ft downwind of work area, 5 ft above roof--removal	---	0.0
			- Installation	---	0.0
		2	Same as No. 1 area--removal	---	0.0

(continued)

TABLE 19 (continued)

Test conditions[a]	Sample No.[b] Man	Area	Specific operation or area sampled	Tools/materials	Fiber level (f/cm^3)[c]
8-76 (continued)		2	- Installation (continued)	—	0.0
		3	Upwind edge of work area, 5 ft above roof—removal	—	0.0
			- Installation	—	0.0
	4		"Tear-off man" (probably cutting and prying off old roofing)	ND	0.0
	5		"Scrap removal man" (probably shoveling and wheelbarrowing old roof material)	ND	0.0
	6		"Asphalt applicator" (probably mopping hot tar)	ND	0.0
	7		"Asbestos paper application" (probably cutting and laying felt)	ND	0.0
8-76 (ND) School at Chesterfield, IN (1,500 sq ft) by Adams Roofing (I)--Johns Manville (Waukegan)		1	2 ft downwind of work area, 5 ft above roof	—	0.0
		2	Same as No. 1 area	—	0.0
		3	Upwind edge of work area, 5 ft above roof	—	0.0
	4		"Asphalt applicator" (probably mopping hot tar)	ND	0.0
	5		"Asbestos paper applicator" (probably cutting and laying felt)	ND	0.0
12-11-79 (15 mph) Office building at Bedford, MA (31,000 sq ft) by unidentified contractor (R,I)—GCA/Technology Division (Eastern Analytical)		1	Corner of roof 25 ft downwind of work area	—	0.00
		2	Edge of roof 25 ft downwind of work area	—	NA
		3	Edge of roof 25 ft downwind of work area	—	0.03
		4	100 ft upwind of work area	—	0.05

(continued)

TABLE 19 (continued)

Test conditions[a]	Sample No.[b]		Specific operation or area sampled	Tools/materials	Fiber level (f/cm^3)[c]
	Man	Area			
12-11-79 (continued)		5	Same as No. 4 area	—	0.01
	5		Cutting, scraping, and shoveling old roof off of deck; sweeping; laying fiberglass insulation and roofing felts, layered with hot asphalt	Removal: circular saw, shovels, wheelbarrows, brooms Installation: ND	0.00

[a]Test conditions include date of sampling (reported wind speed); location (area of work site); roofer (type of operation—R = removal, I = installation); sampling personnel (analysis lab).

[b]Sample No. generally corresponds to sampler's reported data, and two columns indicate whether sampling was performed on a worker (moving) or in a general area (stationary).

[c]Johns-Manville data based on PCM. GCA data based on SEM/EDXR analysis.

ND = No data

NA = Not analyzed

generally follow a logical pattern, with highest concentrations reported for cutting, scraping, and sawing operations as compared to spreading asphalt or unrolling felts, the differences in fiber levels within a given study are less than the differences between studies (generally less than 0.2 f/cm^3). The variations in reported concentrations between studies in which similar materials and operations were used seem to suggest some contribution from the work practices of individual roofers' or from background fiber concentrations. A confusing factor in 4 of the 11 studies was that upwind fiber concentrations were higher than downwind concentrations, and in 3 of the 4 studies they were higher than work site levels. No explanation is given for these unexpected results.

Summary of Findings

There is no secondary processing of asbestos-containing roofing felt. The manufactured material is sold directly or through distributors to the roofing contractor. Asbestos-containing felts are used predominantly in "built-up" roof systems which combine the felts between layers of asphalt or other coatings. These systems are rarely used for residential roofing. The flat or gently sloping "built-up" roof is widely employed on commercial and industrial buildings. Asbestos-containing felts are occasionally used as an underlay for shingle or sheet roofing materials on inclined surfaces.

Felt handling practices employed by roofing contractors tend to be fairly standardized, although a wide range of combinations with asphalt, roof deck insulation, and other felts occur. Felt installation is generally a low energy intensity process, requiring only felt unrolling, "brooming" (removal of underlying air pockets), and mopping with hot asphalt. Only a minor amount of cutting (with a sharp-bladed hand tool) is required. Removal of existing roof material requires greater energy input. Power saws or axes are used to cut the substrate into 0.6 meter (two foot) square or larger blocks, which are then pried off and scraped from the underlying deck using crow bars and shovels.

Despite the variety of cutting and scraping operations that are performed, roofing felts appear to have a low fiber release potential. This probably results from the encapsulation of the fibers during the asphalt saturation step of manufacturing. Also, during installation, as the felts are successively layered with hot asphalt and/or cold coatings, the asbestos fibers are further isolated. In addition, roof weathering is very gradual and fiber release resulting from wind or rain erosion is expected to be minimal. The greatest potential for fiber release exists during roof removal when high-energy mechanical disruption is required to remove sections of felt from the roof deck. Fiber monitoring studies indicate that asbestos roofing felt installation and removal operations result in airborne fiber concentrations that are equal to or less than 0.6 f/cm^3. Table 20 provides a summary of the data presented on asbestos roofing felts and identifies the principal activity of concern with respect to airborne asbestos fiber release.

TABLE 20. SUMMARY OF ASBESTOS ROOFING FELT SECONDARY PROCESSING AND END USE ACTIVITIES

Product: Roofing Felt	Secondary processing	End use
Activity:	No secondary processing performed	Installation; in-service use; and removal
Duration--per incident Daily total		Site-specific; Installation and removal highly variable with roof size and number of felt layers. Actual felt cutting time is estimated to last less than one hour.
Fiber releasability:		Low
Chemical composition		Before asphalt saturation: 85 to 87% asbestos fiber content, remainder filler(s) and binder(s)
Physical composition		Pliable, with a tacky surface
Disruptive energy		Knife or slitting machine during installation; axes, power saws, and hand scraping tools during removal
Control measure(s):		None
Measured fiber concentrations (f/cm^3):		0.0 to 0.6 (ranging from installation to removal)
Environmental setting:		Outdoors

Activity of Concern

Removal (power sawing and scraping) of wornout, brittle felts from roof deck.