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Air Pollution Emissions and Control Technology Asbestos Mining and Milling Industry

Economic and Technical Review
Report EPS 3-AP-76-6

Air Pollution Control Directorate
February 1977

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AIR POLLUTION EMISSIONS AND CONTROL TECHNOLOGY. ASBESTOS MINING AND MILLING INDUSTRY

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ABSTRACT

The present, and future contribution to air pollution by the Canadian asbestos mining and milling industry is evaluated and the best available technology to control these air pollution emissions is defined. Emissions from asbestos mining and milling plants consist mostly of particulate matter containing asbestos fibres. Asbestos has been classified as a significant health hazard subject to Section 7 of the Clean Air Act and, as such, will be regulated by federal emission standards.

Most asbestos plants control emissions from the major part of the milling process so that air from the main mill filters can be recirculated inside the building. Other emission sources require added or improved control to reduce emissions.

RÉSUMÉ

Le présent rapport évalue le tort actuel et future que causent à l'atmosphère les installations d'extraction et de broyage de l'amiante au Canada; il décrit les meilleures techniques antipollution actuellement connues.

Les émissions des mines et usines de broyage se composent surtout de particules où abondent les fibres d'amiante. Ce produit est classé dangereux pour la santé en vertu de l'article 7 de la loi sur la lutte contre la pollution atmosphérique et, à ce titre, il sera assujetti aux normes fédérales relatives aux émissions.

La plupart des usines traitent les émissions de la majeure partie du procédé de broyage de sorte que l'air passant à travers les filtres principaux peut être recirculé à l'intérieur de l'immeuble. D'autres sources exigent des techniques supplémentaires ou améliorées pour réduire la pollution.

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1 INTRODUCTION

1.1 General

In ancient times, asbestos was termed the magic mineral, imparting fire resistant qualities when woven into cloth. When Marco Polo returned from what is now Siberia in the thirteenth century, he brought news of a strange cloth which, when put into a fire, was withdrawn unharmed and became white as snow. This characteristic was also known to the Romans and to peoples elsewhere in Europe. Asbestos, however, remained an oddity until the early twentieth century when many new applications were developed. Its fibrous structure, combined with such properties as non-flammability, excellent flexural and tensile strength heat and electrical insulating ability, and resistance to acids and alkalis, has made asbestos one of the most useful industrial minerals.

Asbestos is the name given to a group of many hydrous silicate minerals, six common varieties of which are, in order of industrial importance: chrysotile, amosite, crocidolite, anthophyllite, tremolite, and actinolite. Chrysotile asbestos accounts for over 90% of the world's consumption and is the only variety mined in Canada. Canada accounts for about 35% of world production (about 65% of that of the western world, if Russia is excluded). Mining of other asbestos minerals takes place primarily in South Africa (amosite), South Africa and Australia (crocidolite), and Finland (anthophyllite). Production of anthophyllite has been phased out in Finland and crocidolite is no longer recovered in Australia. Only minor amounts of tremolite and actinolite are produced, and are used for special purposes.

On the basis of crystal structure, two asbestos groups can be defined: serpentine and amphibole. Chrysotile is a hydrous magnesium silicate belonging to the serpentine group. Host rocks for asbestos in Canada are peridotite and dunite which have been altered to serpentine by the instrusion of mineral-bearing solutions along fractures created during upheavals. Final injection of solutions dissolved some of the changed rock along the fractures and, on cooling, the dissolved rock was precipitated as fibrous crystals. Eventually, the refilled cracks and crevices became a network of fibrous crystalline veins that ran through the altered masses of the surrounding host rock. This would account for the almost identical chemical composition of the chrysotile vienlets and the adjacent serpentine.

1.2 Scope

This study pertains to air pollution control in the asbestos mining and milling industry during the base year 1970, and in 1973, with changes projected for 1974. Size and location of plants; products, and relative importance of the industry to the Canadian economy are discussed. Results from a national emissions inventory are included together with relevant air quality objectives. The cost of pollution control is also estimated.

1.3 Purpose

The primary purpose of this report is to provide the technical information necessary for the preparation of emission standards for the asbestos industry to protect the Canadian public at large, as required by the Clean Air Act of 1971. Recommended emission standards have evolved from information in this report as well as from data collected from other sources, such as emission testing by Environment Canada.

This report also provides information to update the national emissions inventory on asbestos published by the Air Pollution Control Directorate and to assist in the development of federal briefs, state-of-the-art reviews, and other documents related to air pollution emanating from asbestos mining and milling operations.

1.4 Information Sources

Personal contacts were established with members of the following departments of the Federal Government: Energy, Mines and Resources; Industry, Trade and Commerce; and Statistics Canada.

Discussions, regarding health hazards of asbestos, took place with staff members of the U.S. Environmental Protection Agency in Research Triangle Park, North Carolina; the Quebec Asbestos Mining Association, the Asbestos Information Association, North America; the Asbestos Information Committee (U.K.); and various other organizations.

Copies of original articles were obtained from the National Science Library, through the reference section of the Library of the Department of Environment; the U.S. Environmental Protection Agency, the Occupational Health and Safety Administration and other agencies. Articles in the trade literature were also reviewed.

Valuable information concerning atmospheric emissions was also derived from completed questionnaires submitted by Canadian asbestos companies in August, 1974. The English version of the questionnaire is reproduced in Appendix II.

2 INDUSTRY DESCRIPTION

2.1 Size

In 1970, there were 13 producing asbestos mines in Canada with a total production capacity of 92 400 short tons of ore per day. The largest had a rated capacity of 32 000 tons per day and the smallest 300 tons per day. (1)

In 1973, there were 14 producing asbestos mines in Canada with a total rated capacity of 112 000 short tons per day, an increase of 19 600 short tons per day or 21.2% (2).

Canadian asbestos producers in 1970 and 1973 are listed in Tables 1 and 2 (1,2).

Canadian producers shipped 1 862 976 short tons of crude and milled asbestos fibres, valued at $234 323 000, in 1973. This was an increase of 12.1% from 1 661 644 short tons, valued at $208 146 533, shipped in 1970 (1). Table 3 is a breakdown of production by province for the years 1970 and 1973 (1,2).

TABLE 1 CANADIAN ASBESTOS PRODUCERS, 1970 (1)

Company	Location	Mill capacity (short tons ore/day)
Canadian Johns-Manville Co. Limited - Jeffrey Mine	Asbestos, Quebec	32 000
Asbestos Corp. Ltd.		
British Can. Mine	Black Lake, Quebec	11 200
King-Beaver Mine	Thetford Mines, Quebec	8 000
Normandie Mine	Black Lake, Quebec	6 000
Bell Asbestos Mines Ltd.	Thetford Mines, Quebec	3 000
National Asbestos Mines Ltd.	Thetford Mines, Quebec	3 500
Lake Asbestos of Quebec Ltd.	Black Lake, Quebec	6 000
Flintkote Mines Ltd.	Thetford Mines, Quebec	2 000
Carey-Canadian Mines Ltd.	East Broughten, Quebec	4 000
Advocate Mines Ltd.	Baie Verte, Newfoundland	6 000
Cassiar Asbestos Corp. Ltd.		
Cassiar Mine	Cassiar, British Columbia	2 400
Clinton Creek Mine	Clinton Creek, Yukon	3 000
Johns-Manville Mining and Trading Ltd.		
Reeves Mine	Timmins, Ontario	5 000
Hedman Mines Ltd.	Matheson, Ontario	300
TOTAL		92 400

TABLE 2 CANADIAN ASBESTOS PRODUCERS, 1973 (2)

Company	Location	Mill capacity (short tons ore/day)
Canadian Johns-Manville Co. Limited - Jeffrey Mine	Asbestos, Quebec	33 000
Asbestos Corp. Ltd.		
British Can. Mine	Black Lake, Quebec	12 400
King Beaver Mine	Thetford Mines, Quebec	12 000
Normandie Mine	Black Lake, Quebec	7 500
Asbestos Hill Mine	Putuniq, Quebec	6 000
Bell Asbestos Mines Ltd.	Thetford Mines, Quebec	3 000
National Asbestos Mines Ltd.	Thetford Mines, Quebec	3 500
Lake Asbestos of Quebec Ltd.	Black Lake, Quebec	9 000
Carey-Canadian Mines Ltd.	East Broughten, Quebec	5 500
Advocate Mines Ltd.	Baie Verte, Newfoundland	7 500
Cassiar Asbestos Corp. Ltd.		
Cassiar Mine	Cassiar, British Columbia	3 300
Clinton Creek Mine	Clinton Creek, Yukon	4 000
Johns-Manville Mining and Trading Ltd. Reeves Mine	Timmins, Ontario	5 000
Hedman Mines Ltd.	Matheson, Ontario	300
TOTAL		112 000

2.2 Employment

In 1970, 6186 people were employed in the Canadian asbestos mining and milling industry. This increased to 6430 by 1973 (3). A breakdown of employment is given in Table 4.

2.3 Products

Asbestos mills produce several grades of fibre that are shipped to consumers for use in the manufacture of various products. The fibre is classified and priced by grade based on fibre length from longest to shortest. The fibres may be classed in three general categories:

Long Fibres	–	Crude #1
		Crude #2
		Group 3 – Spinning
Medium Fibres	–	Group 4 – Cement Grades
		Group 5 – Paper, Asbestos, Cement and Molded Products
		Group 6 – Stucco, Paper and Molded Products
Short Fibres	–	Group 7 – Shorts
		Group 8 – Sand
		Group 9 – Gravel and Stone

2.3.1 Quality Control. All early production of chrysotile asbestos was by mines located in the Eastern Townships of Quebec, and was primarily of crude fibres and groups 3 to 5 milled fibres. Customers were unable to select fibres with similar characteristics from different companies. With the formation of the Quebec Asbestos Producers Association standard grades were established. Crude fibres were classified as previously but milled fibres were subjected to the Quebec Standard Test (4) to ensure a guaranteed minimum shipping test for the various grades. As more uses were developed for shorter fibres this test was extended to include them and about 34 regular grades were established.

Use of all grades of asbestos fibres has increased from approximately 400 applications in 1950 over 4000 in present-day industry. Further consumer requirements resulted in minor variations of the above categories so that there are now more than 100 grades (fibres tailored to individual customer's specifications). The establishment of producers elsewhere in Canada introduced fibres having different characteristics. While the Quebec Standard Test is used to give some idea of general grades, up to 30 other tests are used in quality control to satisfy customer requirements (4). Some of the most common tests are: Quebec Standard Test, Bauer-McNett, Ro-Tap Screen Analysis, Fibre Strength Unit Test, Loose Bulk Density, and Wet Bulk Density. Other tests are performed to define special characteristics, for different uses by manufacturers.

TABLE 3 ASBESTOS PRODUCTION BY PROVINCE (1, 2)

Province	Production 1970 Short tons	1970 $	1973 Short tons	1973 $
Quebec	1 367 524	161 583 510	1 648 000	185 170 000
British Columbia	86 730	16 033 827	113 000	23 182 000
Yukon	105 638	13 927 652	99 000	14 849 000
Newfoundland	62 727	11 669 402	80 000	13 950 000
Ontario	39 025	4 932 142	34 000	3 850 000
TOTAL	1 661 644	208 146 533	1 974 000	241 001 000

TABLE 4 EMPLOYMENT IN CANADIAN ASBESTOS MINES AND MILLS (3)

	Number of employees 1970	1972	1973
Male	6 145	6 209	6 379
Female	41	57	51
TOTAL	6 186	6 266	6 430

2.4 Location and Geographic Distribution

The Canadian asbestos mining and milling industry is distributed across Canada in four provinces; Newfoundland, Quebec, Ontario and British Columbia. There is also one mine in the Yukon Territory.

The bulk of the industry is located in the Eastern Townships of Quebec, as shown in Figure 1, and this province accounts for approximately 82% of Canadian chrysotile asbestos production.

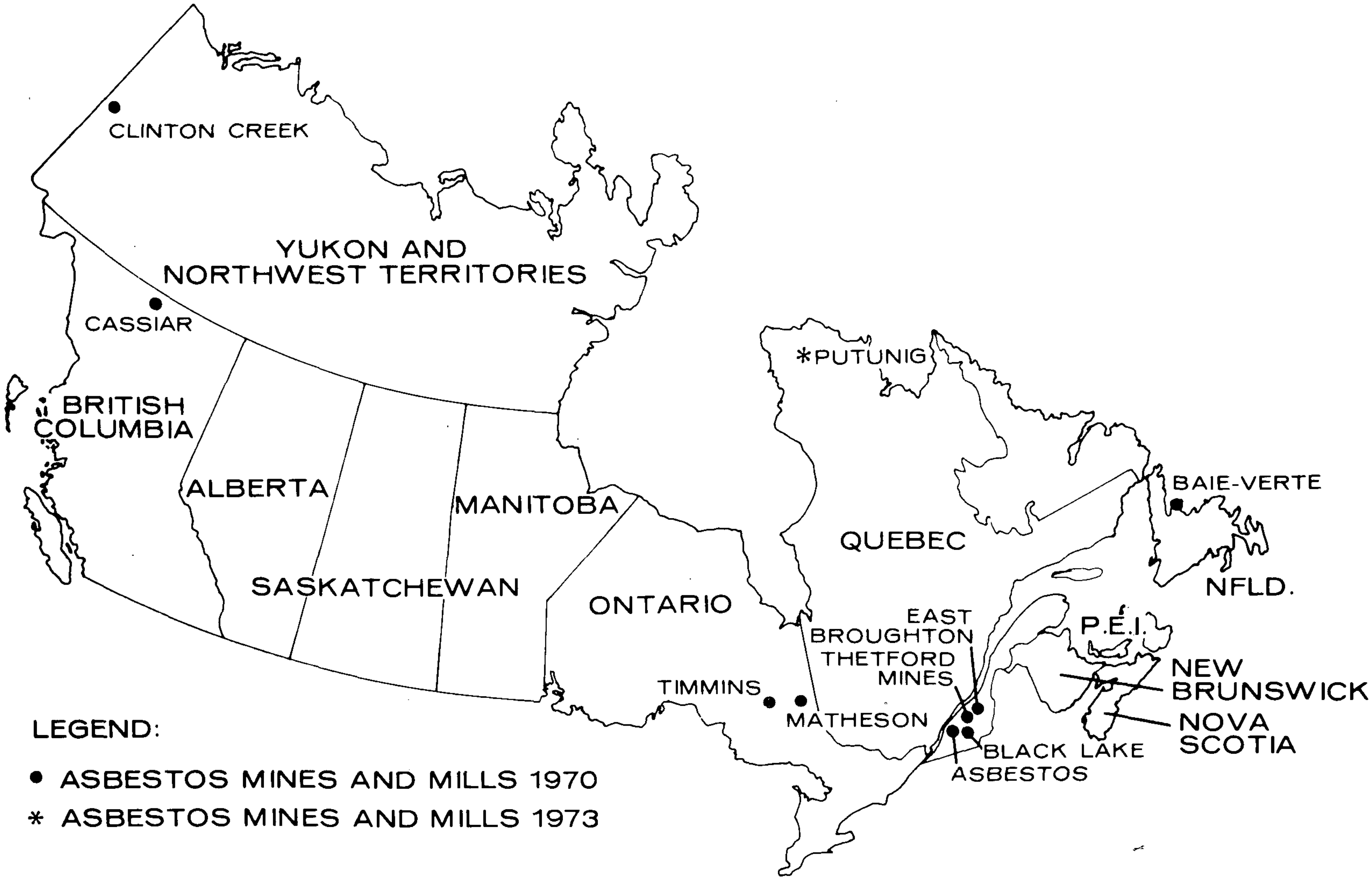

FIGURE 1 ASBESTOS MINES AND MILLS IN CANADA 1970-1973

2.5 Relative Importance

Because of its unique properties, asbestos is one of the most useful industrial minerals. The most common uses of asbestos, listed in magnitude of consumption by North American manufacturers, are in: asbestos-cement products, asbestos latex sheet, floor tile, asbestos paper, friction materials (brake linings, clutch facings), asbestos textiles, plastics, and joint cement. A balance of about 18.5% is consumed in the production of miscellaneous products (5).

3 INDUSTRY PROCESS

3.1 General

In Canada the entire asbestos extraction process is a dry milling operation. Ore from the mine, after being reduced in size by crushing, is dried and delivered to the dry-rock storage building. The dried ore is then conveyed to the mill where it enters the rock circuit and is repeatedly crushed and screened, the freed fibres being aspirated at each stage. Final rock and dust rejects go directly to tailings. The asbestos collected in the initial aspiration stage is further processed in the fibre circuit where it is subjected to repeated screening and grading to remove rock and dust from the fibre and separate grades. The clean fibre is aspirated to bins from which various grades are drawn and packaged for shipment.

The flow of ore through a typical asbestos mill is illustrated in Figure 2.

3.2 Process Sequence

3.2.1 ***Mining.*** Over 95% of all asbestos ore in Canada is mined in open pit operations. After drilling and blasting, broken ore is loaded by large shovels into trucks, ranging in capacity from 35 to 200 tons, and is hauled to the primary crusher. Overburden and waste rock removed in development of open pits is similarly loaded and hauled to waste dumps.

A minor amount of ore is mined by underground caving methods below former open pits, crushed, and hoisted to surface, after which it is treated as ore mined in surface operations.

3.2.2 ***Crushing and Screening.*** Primary crushing reduces ore to about 6 in. in size. Ore is screened and oversize is reduced to a maximum size of approximately 3 in. after which it is conveyed to wet-rock storage or directly to the dryer building.

3.2.3 ***Drying.*** Ore delivered by conveyor from wet-rock storage or from the primary crusher is screened, with the undersize going directly to the dryers. In some instances, a middle cut is made which may go to the drying circuit or may bypass the dryers and subsequently join the dried ore stream. The oversize from this screening operation is further crushed and may or may not be concentrated before rejoining the ore stream. The ore is dried in fluid-bed, vertical or rotary dryers, the last being the most common. The fuel used is coal, oil or natural gas. Prior to drying, the ore might contain from 3% to 18% moisture, depending upon the season. Drying time ranges from 1 to 15 min with inlet air temperatures of 900° to 2000°F. Outlet gas temperatures are maintained between 150° and 400°F to prevent damage

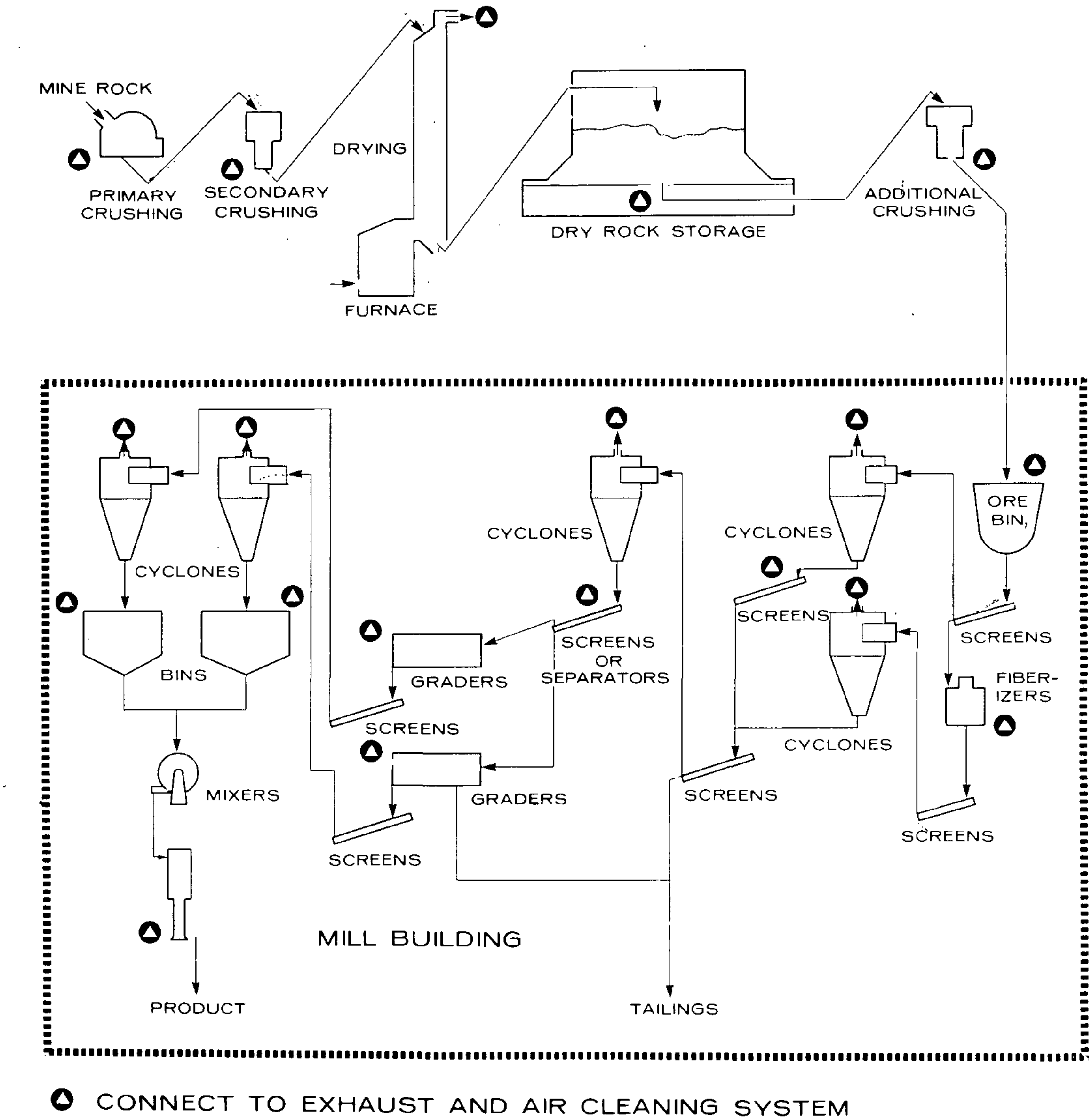

FIGURE 2 FLOW DIAGRAM FOR MILLING OF ASBESTOS ORES

to bags in dust collector units. Ore from the dryers is joined by any ore that bypassed the dryers and is conveyed to the dry-rock storage building where the residual heat in the ore is sufficient to complete drying. The capacity of dry-rock storage facilities ranges from that necessary for one day's operation to that for more than a week's supply of mill feed.

3.2.4 ***Rock Circuit.*** Ore from dry-rock storage is run over shaking screens equipped with aspiration hoods at the discharge end. The shaking action of the screen separates the freed fibre from the rock, which is then lifted by air suction through the hood. The fibre is pneumatically conveyed to a cyclone separator where it is removed from the air stream for further processing. The undersize or thrus from this operation may be further processed in a fibreizer and additional freed fibre removed by subsequent screening. The oversize, or rock passing over the end of the screen after aspiration of fibre, is subjected to further crushing to free more fibre for removal in a similar screening operation. This process is repeated, preferably using impact breakers, some of which are air swept to minimize fibre damage, until all the remaining rock going over the final screen is reduced to minus 1/4 in. The difference between crushers and impact breakers or fibreizers should be noted. A crusher breaks the rock by pinching and compressing it, whereas impact breakers and fibreizers reduce rock size by impact, with no attrition to reduce the length of, or weaken, the fibres released in the process.

3.2.5 ***Fibre Circuit.*** The asbestos recovered from initial separation in the rock circuit contains dust, rock particles and some unopened fibre bundles. This is passed over cleaning screens and the fibre is aspirated. The undersize dust is discarded to tailings. The discharge of coarser material, consisting of unopened fibre bundles and rock particles is treated in a fibreizer, rescreened and the fibre aspirated before final discard to tailings.

The fibre collected is run through rotary tromel dusters and/or over cleaning screens. The longest fibre is separated by different grading methods, run over a screen, aspirated and collected for bagging. Successives stages separate the remaining fibre into its respective classes by length.

3.2.6 ***Tailings Disposal.*** Tailings consist of rejects from various points in the milling circuit and vary widely in particle size. The finest, and most readily airborne, is dust from the large baghouses serving the main mills. This is made up of floats from fibre aspiration mixed with all the dust collected in the dust control system throughout the plant. To this is added dust from the fibre circuit (thrus), dust from screening in the rock circuit, rock particles from cleaning, rock rejects or oversize from the final fibre screens in the rock circuit, and finally any coarse rock discarded in early ore concentration before milling. This is transported by belt conveyor to the tailings pile or hauled to a disposal area.

3.2.7 ***Bagging and Shipping.*** Graded fibre is drawn from its respective lines and delivered to the bagging area where it is either loose packed in multiwall paper bags or pressure packed in units of 100lb net weight. Most fibre is pressure packed. Pressure-packed fibre is sealed in multiwall paper, poly or coated woven poly bags. The packaged fibre is then palletized in units of one or two tons and stockpiled in the fibre storage warehouse to await shipment.

4 POLLUTION ASPECTS

The main pollution problem for asbestos mining and milling operations is the emission of particulates containing varying amounts of asbestos fibres, depending upon where, in the extraction process, emissions occur.

Nearly all the asbestos-bearing ore in Canada is mined by open pit methods which result in dust from drilling, blasting and hauling ore to the mill.

Since fibre is extracted by a completely dry process, dust is generated in various phases of the operation, which must be well controlled.

The sources of emissions are aspiration of fibre in the mill, drying of ore, dust control in the mill, bagging, crushing ore prior to drying, and tailings disposal. Possible sources of particulate emissions, listed in production sequence are:

1. Open pit operations
   - (a) Drilling
   - (b) Blasting
   - (c) Loading broken rock
   - (d) Transporting ore to primary crusher or waste to dump

2. Crushing ore
   - (a) Unloading ore from open pit
   - (b) Primary crushing
   - (c) Screening
   - (d) Secondary crushing
   - (e) Conveying and stockpilling wet ore

3. Drying ore
   - (a) Conveying ore to dryer building
   - (b) Screening
   - (c) Drying
   - (d) Tertiary crushing
   - (e) Conveying ore to dry-rock storage building
   - (f) Dry-rock storage

4. Milling*
   - (a) Conveying ore from dry-rock storage to mill rock circuit
   - (b) Screening
   - (c) Fine reduction of rock in impact breakers and/or fibreizers

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* Confined to mill building, no direct emissions from milling operations. Mill air and all dust collected passed through high-efficiency fabric filters before exhausting to atmsophere.

		(d)	Aspiration of fibre
		(e)	Cleaning screens
		(f)	Graders
		(g)	Aspiration of fibre products
		(h)	Conveying fibres to bagging facilities
		(i)	Bagging operations
5.	Shipping	(a)	Transporting bagged fibre, to fibre storage warehouse
		(b)	Loading products from fibre storage warehouse into railroad cars or transports
6.	Tailings disposal	(a)	Conveying or hauling tailings to tailings pile or disposal area
		(b)	Tailings conveyer discharge
7.	Fugitive dust		

5 HEALTH EFFECTS

It has been determined that prolonged continued exposure to particulates containing asbestos fibres may, in some persons, result in the development of asbestosis, a bronchial or asthmatic disorder. Recent research has also disclosed a connection with certain types of lung cancer. While there is some evidence that crocidolite and other types of asbestos fibres may be more harmful than chrysotile, available data are insufficient to allow any conclusion as to the relative danger of exposure to different forms of asbestos. The asbestos industry has done much to improve the in-plant working environment at mines in Canada. Dust control in working areas of the plants has been improved and emissions to the atmosphere greatly reduced. Concern for the health of employees and the public has been the main reason for a continuous program, dating back to the initial detailed study on the hazard of airborne asbestos to health, undertaken by the Quebec Asbestos Association in 1956.

Section 7 of the Clean Air Act authorizes the Governor in Council to prescribe national emission standards where emissions 'would constitute a significant danger to health of persons'. The Department of National Health and Welfare concluded that it would not be prudent to permit uncontrolled contamination of the public environment with asbestos and that if the continued use of this mineral is to proceed with minimal risk to the public, the major sources of man-made asbestos emitted into the atmosphere should be subject to control. As a result of the statement by the Department of Health and Welfare, the asbestos mining and milling industry will be subject to a National Asbestos Emission Standard Regulation under Section 7 of the Clean Air Act. This is established by the Federal Government, after a review of recommendations from an industry-government task force.

6 NATIONAL EMISSION INVENTORY DATA - PARTICULATES

6.1 Data Previously Published.

Emissions of particulates from all heavy industry during 1970 amounted to 1 309 000 tons or 7.6% of the total emissions of major pollutants in Canada, as reported in a national inventory of air pollution emissions. Particulate emissions from heavy industry during 1970 are listed in Table 5. It can be seen that emissions of particulates containing asbestos totalled 80 000 tons in 1970.

TABLE 5 PARTICULATE EMISSIONS FROM INDUSTRIAL PROCESSES, 1970 (7)

Industry	Emissions (tons/year)*
Iron and steel	153 000
Other primary metals	111 000
Metallurgical coke	11 000
Petroleum refineries	1 000
Cement	248 000
Lime	54 000
Kraft pulp mills	86 000
Asbestos**	80 000
Stone, sand, gravel	401 000
Grain handling	83 000
Grain mills	4 000
Other	77 000

* These figures were based on the results of a paper search of published information from various sources.

** It must be noted that only part of these particulates consist of asbestos fibres.

Asbestos emissions related to the production, manufacture and consumption of asbestos are shown in Table 6 (8).

6.2 Data Obtained from Industry Questionnaires, 1974

Major production of asbestos is by mines located in the Province of Quebec, as shown in Table 7.

TABLE 6 ASBESTOS EMISSIONS IN CANADA, 1970 (8)

	Emissions		Emission factor (lb/ton asbestos)
Source	Tons	Percent	EPS 1970 study
PRODUCTION			
Asbestos mining	6620	40.4	8
Asbestos milling	9673	59.0	11.7
Production total	16293	99.4	
MANUFACTURING			
Asbestos-cement products	1.88	0.01	0.15
Floor tile industry	0.75	*	0.15
Paving	0.44	*	0.15
Coating, caulks, sealants	0.42	*	0.15
Insulation	0.57	*	0.30
Friction materials	0.99	*	0.90
Plastics	0.09	*	0.15
Textiles	0.11	*	0.30
Paper	0.05	*	0.15
Miscellaneous	0.13	*	0.15
Manufacturing total	5.43	0.03	
CONSUMPTION			
Construction industry	0.90	*	0.15
Sprayed insulation	2.18	0.02	10.00
Brake linings			
Installation	18.00	0.11	10
Wear	72.00	0.44	40
Consumption total	93.08	0.57	
TOTAL	16391.51	100.00	

* Negligible (less than 0.01%)

TABLE 7 DISTRIBUTION OF ASBESTOS INDUSTRY BY PROVINCE, 1970 and 1973

Province	1970** Plant capacity tons/day	1970** Ore processed tons/yr	1973 Plant capacity tons/day	1973 Ore processed tons/yr
Newfoundland	6 000	2 201 655	7 500	2 173 700
Quebec	75 700	30 713 727	91 900	31 101 377
Ontario	5 300	1 251 545	5 300	853 601
British Columbia*	5 400	2 516 570	7 300	2 872 519
TOTAL	92 400	36 683 000	112 000	37 001 197

* Includes Clinton Creek Mine, Yukon Territory
** Data from Canadian Mineral Survey 1970 E.M.R. (1)

Data reported in questionnaire submissions resulted in the compilation of total particulate and asbestos emissions from the Canadian asbestos mining and milling industry, shown in Table 8, for the years 1973 and 1974.

If all sources had been fully controlled by the application of 'best available technology' the overall emission of total particulates would have been 73.8% less, as shown in Table 9.

7 CONTROL METHODS

7.1 General

Emission of asbestos fibre contained in particulate matter, especially that released from drying operations, is the most significant air pollution problem faced by the asbestos mining and milling industry. Technology exists to reduce such emissions to low levels and has already been used at some locations. Particulates emitted at other points in the asbestos fibre extraction process are controlled to varying degrees by dust collection systems using mechanical collectors and/or baghouses. The latter generally, give a better degree of control.

7.2 Existing Installations

7.2.1 Open Pit Mining. Dust, from drilling, can be controlled by mounting collectors on the drills. Emissions, from blasting, are uncontrolled but, because blasting is infrequent and of short duration,

TABLE 8 SUMMARY OF EMISSIONS FROM THE ASBESTOS MINING AND MILLING INDUSTRY - 1973 AND 1974

Year and location	Fibre produced (all grades)	Emissions (short tons per year) Crushing		Drying		Dry Rock Storage		Milling		Total asbestos I		Tailings*		Grand total	
		Tot. part.	Asbestos	Tot. part.	Asbestos	Tot. part.	Asbestos	Tot. part.	Asbestos	Tot. part.	Asbestos	Tot. part.	Asbestos	Tot. part.	Asbestos
1973															
Quebec	1 470 340	1934	125	22 298	2097	105	8	14 065	4268	38 402	6498	120 195	777	158 597	7275
Balance Canada	324 709	1985	190	13 082	651	27	2	656	57	15 750	900	55 515	713	71 265	1613
Total Canada	1 795 049	3919	315	35 380	2748	132	10	14 721	4325	54 152	7398	175 710	1490	229 862	8888
1974															
Quebec	1 510 354	2354	156	11 416	571	103	5	17 219	5327	31 092	6059	124 739	746	155 831	6805
Balance Canada	290 622	1869	159	9 454	402	25	1	629	51	11 977	613	39 060	456	51 037	1069
Total Canada	1 800 976	4223	315	20 870	973	128	6	17 848	5378	43 069	6672	163 799	1202	206 868	7874

Data obtained from questionnaires, APCD 1974
*Estimate only (Tailings)
Asbestos emissions are estimates only, obtained from an assumed percentage of asbestos in particulates

TABLE 9 ESTIMATED PARTICULATE EMISSIONS FOR 1974 FROM THE ASBESTOS MINING AND MILLING INDUSTRY IF BEST AVAILABLE TECHNOLOGY WERE USED

	Quebec		Balance of Canada		Total Canada	
	Total particulates (tons)	% Reduction	Total particulates (tons)	% Reduction	Total Particulates (tons)	% Reduction
Crushing	47.64	98.0	13.82	99.3	61.46	98.5
Drying	180.70	98.4	34.30	99.6	215.00	99.0
Dry-rock storage	32.27	68.5	5.04	80.0	37.31	70.8
Milling	1 258.92	92.7	257.39	59.1	1 516.31	91.5
Tailings	42 548.85	65.9	9 926.38	74.6	52 475.23	68.0
Total	44 068.38	71.7	10 236.93	79.9	54 305.31	73.8

emissions are usually insignificant. It should be noted, however, that the total emission from several small blasts might be much less than that from a very large blast. Dust generated while loading trucks and hauling ore (rock) to the primary crusher, stockpile or waste dump is not controlled but is considered minor. Fugitive dust raised from roads is controlled by wetting the travel surface during dry weather.

7.2.2 Crushing. Pit-run ore is reduced in size by crushing before being conveyed to the wet ore stockpile or the dryer building. Dust generated during primary crushing, screening, and secondary crushing is controlled by high-efficiency cyclones and/or baghouses. Baghouses, with extremely high efficiency, are more common in modern plants.

7.2.3 Drying Operations. Ore is delivered to the dryer building by conveyor from the wet-ore stockpile or the crusher building. The ore is split by screening, the undersize going directly to the dryers. The oversize is reduced by tertiary crushing and joins the ore stream, before or after drying depending upon which plant is considered. Fluid bed, vertical, and kiln-type rotary dryers are used to reduce the moisture content of the ore from 3% to 18%, depending upon season and weather conditions, to less than 1.5%. Large volumes of hot air are used for this purpose and uncontrolled emissions of particulates, containing some asbestos fibres, are quite high. The exhaust gases are passed through cyclone separators or cyclone separators followed by a wet scrubber, electrostatic precipitator, or baghouse to reduce emissions. Modern plants use baghouses, alone or following cyclone separators. Some older plants are adding baghouses after cyclones to reduce emissions from this source.

7.2.4 ***Dry-Rock Storage.*** Ore from the dryers, mixed with ore fractions that bypassed the dryers, is conveyed to the dry-rock storage building where residual heat completes the drying of the ore to a uniform moisture content of less than 1.5% Some emissions occur through louvers in the roof of this building. In two instances, a baghouse has been installed to prevent emissions from this source and baghouse installations are being considered at other locations.

7.2.5 ***Milling.*** Milling of asbestos ore is a completely dry process. Extraction of asbestos fibres is achieved by successive stages of reduction in ore size, using crushers, impact breakers, and fibreizers to release fibre, followed by screening and aspiration of the freed fibre. All air used in aspiration and pneumatic conveying of fibre passes through cyclone collectors to remove the fibre after which the air is passed through the main mill baghouse, which may be under positive or negative pressure. The mill dust-control system to eliminate dust from screens, crushers, impact breakers, fibreizers, conveyor transfer points, bagging area, or any other areas in the mill, is also connected to the main baghouse. Some central vacuum-cleaning systems have been installed which have their own baghouse. Air from the clean-air side of the baghouse is exhausted to the atmosphere by large fans during summer months or recirculated in the mill to conserve heat during cold weather.

7.2.6 ***Conveyor Galleries.*** At better controlled plants, emissions of dust from galleries in which ore and tailings are conveyed are eliminated by installing baghouse units at all transfer points.

7.2.7 ***Tailings Disposal.*** Tailings disposal operations have always been a bothersome emission source considered to be of a fugitive nature, over which some control is necessary to minimize contamination of the ambient air.

Rejects from asbestos milling operations may contain up to 50% - 60% plus 1/2-in. material from early concentration and rejects from initial rock circuits. To this are added fines from the rock circuit, dust from the fibre circuit and very fine dust (floats) from the main mill baghouses or baghouses on dust control systems, which can account for 4% to 6% of the total rejects. At one location all tailings are less than 3/8 in. and different methods of emission control may be used.

The very fine dust (floats) from the main mill baghouses is most readily airborne and contains more asbestos fibres since most of it is removed from process air used in aspiration, transportation and separation of fibres released in milling ore. Experiments at one plant have shown that if minus 30 mesh material is agglomerated to form plus 30 mesh particles over 90% of the outside dust problem can be eliminated. Further experimental work is required to determine how variations of this procedure might be used at other plants to reduce emissions from tailings operations.

Two companies transport tailings from the mill to the tailings disposal area by railroad cars.

At one location, tailings collected from various points in the milling circuit, combined with dry material from the baghouses, are conveyed to a storage silo with a live capacity of 1000 tons. From here it is loaded into 30-ton, side-dump railroad cars and transported to the dump. As the face of the dump becomes full, the track is moved sideways and the procedure repeated. This company plans to change to 35-ton rear-dump trucks with low-profile conveyor unloading to minimize dust during dumping.

At the second location, tailings are collected in a similar manner and conveyed to two large storage silos. Baghouses are installed at transfer points of the belt conveyor system. The railroad cars are chute loaded from these silos and loads are lightly sprayed with water in the summer months to minimize airborne dust during hauling to a low-profile dump in a valley three miles away. Cars are dumped by remote control from the air-conditioned cab of the locomotive. Dumped tailings are levelled by rubber-tired bulldozers with air-conditioned cabs. It is planned to use a water truck to wet down new tailings before and after levelling. Various plans are also being considered to pug fine tailings with water before conveying to the storage bins to further reduce airborne dust.

All other companies convey tailings from mills to tailings dumps nearby by belt conveyors inclined at plus 14°. These tailings piles, at point of discharge, can be up to 500 ft above the ground. Some conveying systems have no dust control at transfer points or at the point of discharge. High-speed stackers or flingers, operating at up to 2800 fpm, are still used at a few plants to reduce the number of times that the final conveyor has to be moved. These create a great deal of dust and their use should be discouraged. Elsewhere, tailings are discharged from standard low-profile conveyors and levelled by mechanical means before a build-up of the piles makes it necessary to move the final conveyors. Some transfer points have cyclone collectors to protect mechanical equipment from dust but these exert little control over emissions to the atmosphere. The present trend is to install small baghouses at all transfer points to eliminate emissions from these sources.

Several procedures are being used to reduce dust emissions from tailings operations and others are in the planning stage. Some currently in use are:

(1) At a location where all rejects are minus 3/8 in., the belt conveyor system discharges into an open-bottom screw conveyor which pushes the tailings over the crest of the dump, eliminating any fall and minimizing dust created at the discharge point. Installation of a water spray system around the point of discharge is planned. This system cannot be applied at mines where rejects contain fragments up to 1 in. or more.

(2) At another plant, floats and rejects of various sizes are collected on a common belt conveyor and then run over a screen to segregate coarser waste rock for use in surfacing pit roads. This precludes any prior treatment of floats or fine rejects. Water is then sprayed on the first tailings conveyor following this screening operation. After spraying, the belt runs under a plow which aids in mixing and wetting dry tailings. Further mixing takes place at transfer points. High-speed stackers are used at mines

treating tailings in this manner but will be replaced by low-profile belt conveyors, at the final discharge point.

(3) At one of the better controlled facilities fine dust and floats from mill baghouses are always pugged with water. When weather permits, the first conveyor belt is sprayed with water after the addition of fine and medium rejects. Coarse rejects from ore concentration are added last and no further water sprays are used. More intimate mixing and wetting occurs at transfer points on the tailings conveyor system. Small baghouses are installed at all transfer points to eliminate emissions. A standard low-profile conveyor is used at the final point of discharge to the tailings pile. Buildup is levelled mechanically to minimize relocation of this final conveyor. Icing on belts and at transfer points prevents the use of water sprays during extremely cold weather.

(4) All tailings except coarse rejects from the rock circuit are treated with water at one location. Dust and floats from the mill baghouses are combined with fine rejects from milling and pugged with water. This treated material is then joined by coarse rejects from the rock circuit and conveyed to the tailings dump where it is discharged by a low-profile standard belt conveyor. Buildups are levelled mechanically. Icing occurs on belts and at transfer points during very cold weather. Conveyor galleries are currently being enclosed and insulated and it is planned to exhaust hot air from the mill up these galleries to prevent icing. Baghouses will also be installed at all transfer points.

(5) At another plant, all tailings except coarse rock rejects from the concentrator circuit are pugged with water before being combined with the coarse material and conveyed to the tailings dump. This gives reasonable control of emissions from tailings handling. The pugging operation has to be shut down during the winter, however, because of buildup of frozen material at transfer points and icing of the conveyor belts. All flights of the tailings conveying system, except the first, are open and hooded. Dust is not controlled at transfer points. Final discharge is from a high-speed stacker (flinger) conveyer. This undesirable piece of equipment will be replaced by a low-profile standard conveyor to reduce emissions. Enclosure of the conveyor galleries is also planned as well as the installation of small baghouses at transfer points. Various means are being considered to make the pugging system operative at all times.

7.3 New Technology.

In the past, several unsuccessful attempts were made to simplify or shorten the extraction process. For example an attempt to separate rock, dust, and aspirate fibre in one machine resulted in complete failure.

Various methods for initial concentration have been developed to reduce the amount of ore that must be completely milled for fibre recovery. One new method of separating fibre, rock and dust shows promise of reducing the total number of screens in the milling circuit.

Most other work has been directed towards improving operation and dust control by more efficient application of known technology.

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APPENDIX I - CODE OF GOOD PRACTICE FOR TAILINGS DISPOSAL FROM ASBESTOS MILLS

GENERAL

Tailings from asbestos mills consist of floats from the main mill baghouse, fine serpentine dust from fibre cleaning operations, fine undersize screenings from the rock circuits, oversize from the last screens in the rock circuit, and coarse rock rejects from early upgrading of ore during crushing. These products contain different amounts of free fibre but the most bothersome products are the floats from the main baghouse which consist of very fine particulate matter containing wispy fibres of various lengths. The floats are the most readily airborne asbestos particulates and are the greatest contributors to emissions from tailings disposal operations.

METHODS OF DISPOSAL

Two companies currently haul tailings to disposal areas in side-dump railroad cars.

One of these companies packages part of the floats from the main mill baghouse for sale to consumers. The remaining floats are combined with other tailings from various points in the milling circuit and conveyed to a storage silo with a live capacity of 1000 tons. Emissions from this conveyor system are controlled by small baghouses installed at each transfer point. Side-dump cars are loaded from the storage silo and transported to the disposal area. As the face of the dump becomes full, the track is moved sideways and the procedure repeated. No water sprays are used anywhere in the tailings disposal operation. A gust of dust results from the dumping of each car but soon settles. This company plans to switch to 35-ton trucks for tailings transport. These will be equipped with low-profile conveyors to minimize emissions of particulate matter (containing asbestos fibre) from the placing of tailings on the dump.

The second company collects dry floats from mill baghouses and rejects of various sizes and conveys the mixed tailings to two large storage silos. After the cars are loaded, they are lighly sprayed with water to eliminate blowing dust enroute to the disposal area two miles away. The tram operator dumps the cars by remote control from an air-conditioned cab. The dumped material is then levelled and pushed over the crest of the dump by rubber-tired tractors equipped with air-conditioned cabs. This company plans to use a watering truck, both before and after levelling dumped material, to further reduce airborne dust from tailings handling.

All other asbestos mills use belt conveyors to move tailings to the disposal area. These are inclined at about plus 14 and are extended as required so that the point of discharge is, in some instances, about 500 ft above ground. The belts used are usually narrow and operate at high speeds. They may be located in closed galleries or in the open with semicircular hoods to protect them from rain and snow. There may be several transfer points in the conveyor system. Originally there was no dust control equipment at any of the transfer points, even in closed-gallery installations. Thereafter, some cyclones were installed at transfer points. They controlled dust in the galleries at these points and protected mechanical equipment but did little to reduce emissions to the ambient air. The present trend is for small baghouses to be installed at transfer points to control dust and reduce emissions from these sources. Originally, nearly all asbestos mills used high-speed stackers (flingers) at the final discharge point. These operated at speeds up to 2800 fpm. The use of flingers minimized the number of times the final conveyor had to be relocated; however, they created an excessive amount of airborne dust, which made them undesirable. Most companies have replaced flingers with low-profile standard belt conveyors operating at 400 to 500 fpm. Tailings are levelled mechanically before buildup makes it necessary to relocate the conveyor.

AIR POLLUTION ASPECTS

Piles of rejects deposited in the disposal area mount in height as tailings conveyors are extended (at an inclination of plus 14°) so that the tailings dump at the point of final discharge could be up to 500 ft above the surrounding terrain.

Old tailings piles are relatively stable, because repeated rainfall creates a damp crust about six inches thick which prevents any airborne dust resulting from high-velocity winds. Problems exist at the point of tailings discharge to the dump and newly deposited tailings, the fines from which can be readily airborne by winds. After newly deposited tailings become stabilized by rainfall, this problem does not exist. Various methods have been tried to minimize emissions at the final discharge point of the conveyor system and fugitive dust problems from fines in newly deposited dry tailings.

PRESENT PRACTICE IN TAILINGS DISPOSAL

The following examples of present practice of placing asbestos tailings on the dumps by belt conveyor give an idea of the progress being made in the reduction of emissions from tailings disposal operations.

(1) A-low profile standard belt conveyor has been substituted for a high-speed stacker conveyor (flinger) at the point of discharge. Tailings are levelled mechanically to minimize the number of times this final conveyor must be moved.

Before being conveyed to the disposal dump tailings undergo the following treatment at the mill.

(a) All floats and dust from the main mill baghouses are mixed with water in a pug mill before being discharged to the tailings belt. This practice is followed all year, even in very cold winter months.

(b) Fine, medium and coarse tailings are added to the tailings conveyor after the pugged floats. Weather-permitting, up to five water sprays wet down the tailings on the belt. In cold winter weather the number of sprays is reduced to one or even zero. However, since pugging of floats is still done, reasonable control of emissions is achieved during winter months.

(2) All tailings, minus 30 mesh in size, resulting from milling of asbestos ore, are added to floats from the mill baghouses which are then pugged with water. Experiments show that if minus 30 mesh particles are agglomerated to form plus 30 mesh particles, emissions can be reduced 80% to 90%. A low-profile standard conveyor,

which can be swung in a horizontal arc, is used at the point of final discharge. Tailings are levelled mechanically to minimize the number of times this conveyor must be relocated. In very cold weather freezing problems occur (material on belt, on return idlers and snub pulleys) and the system becomes inoperative. The water is then shut off and emissions are uncontrolled. All conveyors but the first are open or semi-hooded. The company is considering enclosing the conveyors, with insulated galleries if necessary. Hot air from the mill will be exhausted up the conveyor way in an attempt to prevent freezing and make the control system operative in cold weather.

(3) All tailings with the exception of coarse rock rejects are collected and pugged with water before being deposited on the first tailings conveyor, after which coarse rejects are added to the belt. All conveyors are open and semi-hooded. A high-speed stacker (flinger) places the tailings on the dump at the point of final discharge. Plans are underway to replace this flinger with a low-profile standard conveyor. The same problem exists for this system as for (2) and it becomes inoperative in very cold weather.

(4) All tailings are minus 3/8 in. Floats and all other rejects are collected on a common conveyor belt and are then placed on the dump by one of two tailings conveyor systems, each having four transfer points. Only one of the eight transfer points is equipped with a baghouse. The point of final discharge is a 24-in. screw, 35 ft long, which is open on the bottom. The tailings are pushed over the crest of the dump by this screw. In the future water will be sprayed around the point of discharge to prevent the transport of material and floats by winds. Warm water will be used during winter months. The replacement of the present two conveyor systems with one system using wider belts operating at a lower speed is currently being considered. It is expected that two transfer points will be required, each of which will be equipped with a baghouse.

It should be noted that this is the only location at which a screw conveyor can be used at the point of final discharge because all rejects are minus 3/8 in.

(5) All rejects are collected on a common belt. Weather-permitting, water is sprayed on this material before it is conveyed to the dump by the tailings conveyor system which has seven transfer points with cyclone collectors and fans installed at each point. The final conveyor placing the tailings on the dump is a swing conveyor. This is a standard belt conveyor operating at conventional speed and suspended in such a manner that it can be swung in a horizontal arc of about 60° to minimize the number of times it has to be installed at a new pick-up point. The fall from the point of discharge is a maximum of 15 ft. Sprays on the collection belt in the mill reduce emissions from tailings disposal somewat but this system becomes inoperative in very cold weather, allowing uncontrolled emissions at that time.

ERRATA

Report EPS 3-AP-76-6

Air Pollution Emissions and Control Technology.
Asbestos Mining and Milling Industry

1. Page 34:

   (6) Line 7:

   "The tailings conveyor system currently has 14 transfer points, 9 of which are equipped with cyclone collectors and with a baghouse."

   should read:

   "The tailings conveyor system currently has 14 transfer points, 9 of which are equipped with cyclone collectors and <u>one</u> with a baghouse."

2. Page 34:

   Paragraph beginning:

   "In case of emergencies ...." should be indented and included in Section (9).

(6) Dry floats from the baghouses and rejects of various sizes are collected on a common belt. This material is then run over a screen to seggregate coarser waste rock rejects for use in surfacing pit roads. Water is sprayed on the finer, undersize material from this screening operation on the belt conveyor feeding the tailings conveyor system. The belt is then run under a plow to turn the material over and aid in mixing and wetting the dry tailings. Further mixing takes place at subsequent transfer points. The tailings conveyor system currently has 14 transfer points, 9 of which are equipped with cyclone collectors and with a baghouse. Four more baghouses are on order for the balance of the transfer points. A high-speed stacker conveyor (flinger) is used at the point of final discharge and increases emissions even when water has been applied to tailings. During very cold weather, little or no water is added to rejects at the mill so this condition is further aggravated at that time.

(7) Rejects are handled in a similar manner to (6) but the tailings conveyor system has nine transfer points, eight of which have cyclone collectors; one has a baghouse. Tailings are deposited on the dump by means of a conventional swing conveyor operating at normal speed. Some reduction in emissions results from the use of the water sprays but these are shut off during very cold weather and emissions from this source are then uncontrolled.

(8) All rejects from milling operations are collected on a common belt and transported to the disposal area by a tailings conveyor system having only one transfer point. A swing conveyor is used to place the tailings on the dump. There is no control of emissions at present.

(9) Dry floats from the mill baghouses are combined with all rejects on a common conveyor belt feeding the tailings conveyor system which has four transfer points, two of which are equipped with cyclone collectors, one with an exhaust fan only. There is no dust control at the first transfer point. Tailings are placed on the dump by one of two Barber Green portables fed by the tailings conveyor system, and inclined at 15° to give a maximum drop of 15 ft.

In case of emergencies, the tailings can be diverted at two of the transfer points to auxiliary systems, each consisting of two portable conveyors, in series. No attempt has been made to reduce emissions from tailings disposal. Two schemes for reducing emissions from the tailings operation are under consideration. The first involves the installation of a pug mill which would treat floats and fine tailings with water before the addition of coarser tailings and rock rejects, all of which would then be conveyed to the disposal area. In the second scheme the catch from the main mill baghouse (floats) would be wetted and agglomerated in a screw conveyor, which would drip them on the main collection conveyor feeding the tailings conveyor system.

Some control of emissions is exerted by the various methods currently used in asbestos mills. The degree of control might better be defined as follows:

(1) (a) Maximum emission control is achieved in warm weather when water sprays are used on the first tailings belt and floats from the mill baghouse are pugged.

(b) The majority of emissions are eliminated by pugging of the baghouse floats only, during the winter months.

(2) Excellent control of emissions is achieved during warm weather; however, the system is inoperative during cold winter months when it is necessary to turn off the water because of freezing conditions on the belts, return idlers, snub pulleys, and at transfer points. Plans are being made to close in, and insulate if necessary, all the conveyor galleries. Warm air from the mill will then be exhausted up the conveyorway in order to eliminate or minimize freezing conditions.

(3) Emissions are well controlled during warm weather but the same condition exists as for (2) and no control is achieved during winter months when no water is added. The high-speed stacker (flinger) should be replaced with a low-profile swing conveyor operating at conventional speeds.

(4) This operation is unique because of the fine size of all mill rejects. The present system and planned improvements should reduce emissions from tailings disposal to an acceptable level.

(5) Some control is achieved during warm weather when water sprays are in use but emissions are uncontrolled during the winter when water cannot be added.

(6) Minimum reduction in emissions takes place during summer months when water is used but emissions are uncontrolled during the winter. Further emissions are created by the high-speed stacker (flinger) that places the tailings from the conveyor system on the dump. This should be removed and replaced with a low-profile swing conveyor to reduce dust created at the point of discharge.

(7) Conditions are the same as (6) with one exception: A conventional swing conveyor is used at the final discharge point instead of a flinger.

(8) No emission controls are used in this tailings disposal system. Plans are currently being made to control emissions.

(9) No emission controls are used in this tailings disposal system other than cyclones installed at some transfer points to protect mechanical drives. Plans are being considered to replace the cyclones with baghouses and install other means of reducing emissions at the point final discharge to the dump.

RECOMMENDATIONS TO REDUCE EMISSIONS FROM TAILINGS OPERATIONS

1. When new or replacement tailings belt conveyor systems are being constructed, consideration should be given to the use of wider conveyor belts operating at slower speeds, with a minimum number of transfer points.

2. No high-speed stacker conveyors (flingers) should be used to place material from the tailings conveyor on the dump. Any units presently in use should be replaced by low-profile swing conveyors operating at conventional speeds at the point of final discharge.

3. All tailings conveyors should be adequately enclosed to prevent windblown dust. This would not be required for the swing conveyor depositing material on the dump or for temporary extensions to the main conveyor system.

4. Air from dust-control systems at transfer points must be passed through pollution abatement equipment that will limit emissions to less than 2 fibres per cubic centimeter before being exhausted to atmosphere. This can be readily achieved using a small, well-maintained baghouse.

5. Tailings must be conditioned before being deposited on the disposal area. When applicable, floats from the mill baghouse should be pugged with water before being deposited on the dump.

6. Whenever possible, water sprays should be used to reduce emissions at the disposal area to a minimum. This will give maximum emission control during warm weather, but reasonable control of emissions will be possible during freezing weather when only floats are treated with water.

7. Where fine rejects are also added to the pug mill along with the floats, provision should be made to have the fine rejects bypass the pug mill so that treatment of the floats alone can continue during the winter.

CONCLUSION

Where these recommendations are followed, tailings operations can be considered to be in compliance with the intent of regulations being promulgated to limit the allowable emissions from crushing, drying, dry-rock storage and milling by the asbestos mining and milling industry.

APPENDIX II - ASBESTOS MINING AND MILLING INDUSTRY. ATMOSPHERIC EMISSIONS QUESTIONNAIRE , JULY 1974

General Instructions

1. All answers are confidential to Environment Canada and to the Ministry responsible for the environment of the province in which the plant is located. Information will be used by the Department of the Environment in the preparation of an industry review and subsequent development of emission standards. Information from the questionnaire, which will be used for published reports will be grouped to avoid identification of the specific source, unless the information has been published elsewhere or the permission of the company has been obtained.

2. Questionnaires should be signed by an authorized executive of the company.

3. One complete questionnaire is to be completed for each plant.

4. Where information is not available from actual measurements, please give estimated values. Indicate estimated data by placing (E) beside answers and explain the method of estimation.

5. When inadequate space has been provided on the questionnaire for your answer, please complete the answer on a separate sheet.

6. Please complete and return the questionnaire within sixty days, retaining one copy for your records, to:

   W.A. Lemmon, P.Eng.,
   Chief, Mining, Mineral, Metallurgy Division,
   Air Pollution Control Directorate,
   Ottawa, Ontario.
   K1A 0H3

   Phone (819) 997-1346

   Further clarification and/or questions may also be directed to the above, or to your Regional Office. A list of the Regional Offices is attached.

7. Please provide a plot plan of your plant which locates and identifies all pertinent facilities and stacks in relation to local municipality.

8. Cost data requested are for Air Pollution Control Equipment only.

REGIONAL EPS OFFICES

Atlantic Region

Dr. C.J. Edmonds
Director, Atlantic Region
Environmental Protection Service
Department of the Environment
P.O. Box 2406
Halifax, Nova Scotia
Phone: (902) 426-3593

Quebec Region

Mr. Ghislain Gauthier
Director, Quebec Region
Environmental Protection Service
Department of the Environment
P.O. Box 1330, Station "B"
Montreal, Quebec
H3B 3K9
Phone: (514) 283-7377

Pacific Region

Mr. R.E. McLaren
Regional Director, Pacific Region
Environmental Protection Service
Department of the Environment
1090 West Pender Street
Vancouver 5, British Columbia
Phone: (604) 666-6711

Ontario Region

Dr. R.W. Slater
Regional Director, Ontario Region
Environmental Protection Service
Department of the Environment
Second floor
135 St. Clair Avenue West
Toronto, Ontario
M4V 1P5
Phone: (416) 996-5840

Environment Canada
Environmental Protection Service
Air Pollution Control Directorate

Asbestos Mining and Milling Industry
Atmospheric Emissions Questionnaire

CONFIDENTIAL

Company Name ____

Plant Location ____

Liaison Officer ______________________________ Telephone ______________

Dated at   on the   day of   19

____
Signature of Authorized Company Executive

PART I - PLANT IDENTIFICATION

1. COMPANY IDENTIFICATION

(a) Parent Corporation ______________________

(b) Operating Division or Subsidiary ______________________

(c) Mailing Address ______________________

P.O. Box No. ______________________

Street and No. ______________________

Post Office ______________________

City Prov. Code

(d) Executive Officer

Name ______________________

Title ______________________

2. PLANT IDENTIFICATION

(a) Plant Name ______________________

(b) Mailing Address ______________________

P.O. Box No. ______________________

Street and No. ______________________

Post Office ______________________

City Prov. Code

Signature of Respondent ______________________

Name of Respondent (typed) ______________________

Title ______________________

Telephone No. ______________________

Date ______________________

PART II – PROCESS INFORMATION

(A) General Information

1. Annual Production of Finished Grades:

Grades	Base Year 1970		1973		Projected 1974	
	Tons	% of Total	Tons	% of Total	Tons	% of Total
1 Crude						
2 Crude						
3 Fibre						
4 "						
5 "						
6 "						
7 "						
7 Floats						
8						
9						

PART II (Cont'd)

2. Annual Throughput of Raw Material

(a) Quantity handled per year:

	Base Year 1970	1973	Projected 1974
Net Tons Mined			
Net Tons Overburden			
Net Tons Waste			
Net Tons Milled			
Net Tons Fibre			

(b) Dust Losses to Atmosphere:

Estimated Net Tons Lost/Year From:	Base Year 1970	1973	Projected 1974
Drilling			
Blasting			
Transportation			
Waste Dumps			
Milling Operations (a) Crushing (b) Drying (c) Milling			
Tailings Dumps			

PART II (Cont'd)

(c) Tailings to Dump:

	Base Year 1970	1973	Projected 1974
Net Tons/Year			
% of Free Asbestos Fibre Retained On 40 Mesh In Tailings			

(d) Shipping:

	Base Year 1970	1973	Projected 1974
Net Tons Shipped in Bulk			
Net Tons Shipped in Bags			
(a) Pressure Pack (b) Valve Type Bags			

(B) Operation Information and Dust Collector Data

1) For *each* Dryer, please complete the attached Dryer Data Sheet.

2) For *each* Dust Collector * please assign a number and complete the attached Dust Collector Data Sheet.

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* Include all dust collectors (including drill collectors) that condition air before it is released to the atmosphere.

3) Complete Table I, cross referencing it to the numbers assigned on the Dust Collector Data Sheet. Please include a general flow sheet depicting the operations in Table I and showing points of dust control.

4) Are all fibre separators provided with a final collector on the exhaust gas? If no, provide emission data from the fibre separator.

5) Open Pit Operation (Present)

Equipment	No. In Use	Type	Capacity	Dust Control Yes/No	Gal. Fuel Used/Yr.
Drills					
Shovels					
Trucks					

6) Are haulage roads wetted for dust control ? What wetting agent is used?

7) Tailings Disposal Area

Capacity of Disposal Area (Acres)	
Size of Dump (Acres)	
Elevation (ft above grade)	
Distance from (ft)	Distance from
Mine	
Mill	
Townsite	

8) Methods of Tailings Disposal

Conveyors	
Number	
Size	
Length	
Type of Final Conveyor	
Dust Control Along Conveyors (Yes/No)	
Other (Specify)	

9) Are dust control measures used on tailing dumps? If yes give details.

10) Does your plant employ a central vacuum system for cleanup or is man sweeping used, or are both used? Where is the collected dust disposed?

11) What conveyance is used for bulk shipments?

12) How are your bulk conveyances loaded?

13) What percentage of bags are broken during handling and shipping?

DRYER DATA SHEET

Type (Rotary, Vertical, Fluid Bed)	
Type Fuel (Oil, Coal, Natural Gas)	
Quantity Fuel Used Per Year (Gal, Tons, MCF)	
% Sulphur in Fuel	
Firing Rate (BTUH)	
Average Size of Ore to Dryer (Inches)	
% Moisture in Ore to Dryer	
% Moisture in Ore from Dryer	
Capacity	
Tons/Hour	
Tons Dried 1970	
Tons Dried 1973	
Projected Tons Dried 1974	
Total Air Volume to Dryer (ACFM)	
Operating Inlet Temperature (°F)	

Assigned Number of Dust Collector that Dryer is Vented to (From Dust Collector Data Sheet)

Dryer Stack Data

	1	2	3	4	5	6	7	8
Height Above Ground (ft)								
Height Above Roof (ft)								
Inside Diameter of Stack (ft)								
Exit Gas Temperature (°F)								
Exit Gas Volume (ACFM)								
Moisture (% by Volume)								
SO_2 in Discharge (% by Volume)								
Dust Loading (grains/ACF)								
% Asbestos Discharged								

Operating Time

	1970		1973		1974	
	Summer	Winter	Summer	Winter	Summer	Winter
Hours/Day						
Hours/Week						
Hours/Year						

DUST COLLECTOR DATA SHEET

Collector Number Assigned	
Operation(s) Vented *	
Make	
Type	
Volume ACFM	
SCFM	
Operating Temperature (°F)	
Air to Cloth Ratio (SCF/FT^2) (Bag Filter)	
Bag Type (Bag Filter)	
Dust Loading In (Grains/ACF)	
Particle Size Distribution In	
Dust Loading Out (Grains/ACF)	
Particle Size Distribution Out	
% Asbestos Out	
Efficiency (%)	
Dust Recovered (Tons per day)	

*If the 'operation(s) vented' is a dryer, and the final collector is preceded by a primary cyclone please complete the Cyclone Data Sheet below.

Stack Data

Item	Stack Data	
Inside Diameter (ft)		
Height Above Ground (ft)		
Height Above Roof (ft)		
Exit Temperature (F)		
Average Operating Pressure Differential (Inches Water Gauge)		
Pressure or Suction Unit?		
Dust recovered returned to process or tailings?		
Conditioned Air to Building or Atmosphere?		
Is a Bypass to Atmosphere Provided?		

CYCLONE DATA SHEET

Number of Dust Collector that Cyclone precedes (From Dust Collector Data Sheet)	
Cyclone Type (singe, twin, multiple, other)	
Volume ACFM	
SCFM	
Operating Temperature (°F)	
Dust Loading In (Grains/ACF)	
Dust Loading Out (Grains/ACF)	
Dust Reocvered (Tons per day)	
Efficiency (%)	
Operating Pressure Differential (Inches Water Gauge)	

ACFM = Actual cubic feet per minute at operating conditions
SCFM = Standard cubic feet per minute at 70°F and 29.92 in. mercury

TABLE I - OPERATING DATA

Operation	Dust Control (Yes/No)	Collector No(s) Vented to (From Data Sheet)	Operation Vented to Outside or Bldg.
Primary Drilling			
Secondary Drilling			
Unloading at Crusher			
Primary Crushing and Conveying			
Secondary Crushing and Conveying to Dry Rock Storage			
Dry Rock Storage			
Drawing from Dry Rock Storage			
Milling			
Tailings Conveying			
Loading			

TOTAL AIR USED IN MAIN MILL (SCFM) ____________________

% OF TOTAL AIR THAT IS USED AS PROCESS AIR (ASPIRATING CONVEYING, ETC.) ____________________

% OF OPERATING TIME THAT AIR FROM MAIN MILL DUST COLLECTOR IS RECIRCULATED TO BUILDING ____________________

PART III - COST DATA

Estimated Cost of Air Pollution Control:

Year	Capital ($)	Operating and Maintenance ($)
1970		
1971		
1972		
1973		
1974		