Safe use of Chrysotile Asbestos

A Manual on Preventive and Control Measures

CHRYSOTILE
Institute

Developed by:
The Asbestos Institute (AI)
Québec Asbestos Mining Association (QAMA)
September 1993 (Updated, January 1998)
Revised 2011, Chrysotile Institute

in Cooperation with:
Instituto Mexicano de Fibro-Industries A.C. (IMFI)

About This Manual

This manual was designed to assist chrysotile asbestos product manufacturers in implementing and/or fine-tuning in-house preventive and control programs to ensure the safe use of chrysotile asbestos throughout the product life cycle.

This manual is intended to be used in conjunction with a two-day training program aimed at senior management and safety professionals, to apprise them of the hazards of chrysotile asbestos, raise awareness of the need for corporate commitments and responsibility, and to educate them on the appropriate preventive and control measures, administrative procedures and communication programs necessary to provide a safe working environment. The workshop, in most cases, will be followed by intensive training courses in industrial ventilation for engineers; and air sampling and fibre counting techniques for industrial hygienists. Case studies and plant visits will also be organized in the context of the overall training effort in order to provide "hands-on" training and to develop practical solutions to various problems found in typical work site situations.

A number of reference materials were used in preparing the manual, including published information of the International Labour Office, the Asbestos Institute, the Asbestos International Association, the Quebec Asbestos Mining Association, the Instituto Mexicano de Fibro Industrias (IMFI) and the Asbestos Information Association / North American (AIA/NA). Various documents of Eternit Belgium and reports by Dr Gordon Bragg, Dr Richard Kuntze and Mr Richard Carothers, have also been consulted.

Special thanks must also be given to the following individuals all of whom made valuable contribution in the development and drafting of this document:

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September 1993

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Foreword

At the request of the Chrysotile Institute, we have reviewed and updated the "Safe Use of Chrysotile: A Manual on Preventive and Control Measures" first produced in 1993 and revised in 1998.

This is a comprehensive document on preventive and control measures, built on the principles of safe use and embraces the ethics of product stewardship. Therefore, the chrysotile industry, in order to ensure its future prosperity must be responsible, not only in its manufacturing operations, but throughout the product life cycle.

The controlled-use technology developed for the chrysotile industry is well known and easily available. The chrysotile industry plays a positive role in promoting this technology. The combined efforts of the various chrysotile industry sectors have made possible the promotion and implementation of guidelines for the responsible-use of chrysotile based on objective, scientific data and recent technological developments.

The controlled and responsible-use of chrysotile along with safe work practices that govern its use, are consistent with the principles of sustainable development. For example, chrysotile-cement products have proven effective in maintaining a cleaner environment, as well as being economical, durable, corrosion resistant, fire-resistant and nonconductive. In addition, its energy content is lower than alternative products.

The Chrysotile Institute (CI) was founded in 1984, and named the Asbestos Institute, with a board of directors comprised of representatives from industry and labour unions. Representatives from the federal and provincial government are invited to participate as observers at board meetings.

The Chrysotile Institute's mandate is to promote the safe and responsible use of chrysotile fibres at home and abroad. By updating this "Safe Use of Chrysotile Asbestos: A Manual on Preventive and Control Measures", the Chrysotile Institute wishes to provide as much information as possible to the chrysotile world. Other useful publications by the Chrysotile Institute include "Basics of Chrysotile Asbestos Dust Control", 4th Edition, 2008.

In cooperating with competent governmental authorities, workers and their representative organizations, the Chrysotile Institute can be helpful in a number of meaningful ways, such as:

- provide technical services in helping the industry introduce appropriate preventive and control programs;
- undertake monitoring of the industry and prepare reports to be submitted to regulatory authorities;
- interface with authorities to address industry and company specific problems that may be encountered; and
- in a more cost-effective manner, develop and implement product stewardship on behalf of the industry.

For most, this is evident. It is important for all to work together – large and small companies, producers and consumers, industry associations, workers and their unions, at both the regional and international levels.

We hope this document will assist and provide all users of chrysotile fibres with the useful information to ensure precautions are taken to protect the health, safety and environment of the workers and general population.

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December 2010

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Chrysotile Asbestos and Health

1. Chrysotile, Asbestos and Health

TABLES AND FIGURES

1.1 THE ASBESTOS FAMILY OF FIBRES

Asbestos was a commercial term given to six naturally occurring minerals that are incombustible and separable into filaments: chrysotile, amosite, crocidolite, anthophyllite, tremolite and actinolite. Chrysotile is the only member of the serpentine group of minerals; crocidolite, amosite and the others belong to the amphibole group.

Today, only chrysotile fibre (white asbestos) is used commercially. Its fibres are characterized by high tensile strength, resistance to alkalies, high flexibility and good spinnability.

Over 90% of the chrysotile produced in the world is used to manufacture chrysotile cement products. In these plants the chrysotile is locked-in at an early stage of the production and all waste can be recycled into the operation which is an ecological advantage for these manufacturers.

1.2 OTHER NATURAL AND MAN-MADE FIBRES

Chrysotile is only one of the many natural fibres. Other naturally occurring mineral fibres include wollastonite and attapulgite. However, as shown in **Table 1,** there are several man-made fibres. Man-made mineral fibres include glass, rock and slag wool, refractory ceramic fibres and whiskers made of silicon carbide. Important organic fibres of interest are the para-aramids and polyacrylonitrile fibres (PAN).

1.3 USE OF FIBRES AND PRODUCTS

The majority of chrysotile fibre (>90%) is used as a reinforcing agent in the chrysotile cement industry whose products include sheets, shingles and pipes.

Because of its frictional properties, thermal resistance and thixotropic characteristics, chrysotile fibre is found in brake linings and clutch facings, resins, asphalt and industrial textiles.

TABLE 1 - VARIOUS NATURAL AND MAN MADE FIBRES

INORGANIC		ORGANIC	
NATURAL	MAN-MADE	NATURAL	MAN-MADE
Aluminium Silicate	Carbide	Cotton	Acrylic
Amphiboles	Carbon	Flax	Aramid
Attapulgite	Ceramic	Hair	Nylon
Bentonite	Glass	Jute	Polyester
Brucite	Mineral Wool	Sisal	Polypropylene
Calcium Silicate	Tobermorite	Wood	Polyvinyl Alcohol (PVA)
Calcium Sulfate	Phosphate	Wool	Teflon
Chrysotile	Koberit		Viscose
Dawsonite	Modified Fibres		Polyacrylonitrile (PAN)
Kaolin	Potassium Titanate		
Perlite			
Sepiolite			
Talc			
Wollastonite			
Zeolite/Erionite			
Zirconia			

All types of asbestos fibres were used as a friable insulation material in various fire resistant, thermal and acoustic insulation applications, including pipe and boiler lagging. These applications are no longer allowed today, because of the potential health risk to workers during installation, maintenance and removal.

Man-made fibres are not without potential health risks and are also used in friable insulation applications. They also have a wide variety of applications in friction products, textiles, acoustics, ceiling tiles, high efficiency filtration, etc.

1.4 ASBESTOS-RELATED DISEASE

Many years ago, dust concentrations, up to 200 f/cc, of different fibre types could be found in certain asbestos industry sectors, particularly those involving friable (spray-on) applications. In many workplace environments, dust clouds were so thick that it was difficult for workers to see each other even at short distances. At the time, workers were subject to high intermittent exposure on work sites. This resulted in a number of asbestos-related diseases among workers, including:

- Asbestosis: the scarring of the lung tissue which can impede normal respiratory function and possibly result in death due to heart failure, respiratory infections; or lung cancer;
- Lung cancer: malignant, invasive growth of tumour in the lung; and,
- Mesothelioma: malignant tumour of the lining of the chest or abdominal cavities.

Evidence regarding the association of asbestos exposure to various other diseases is unclear, particularly in the case of laryngeal cancer and ovarian cancer. In the case of gastrointestinal cancer, laboratory experiments have failed to produce gastrointestinal tumours in animals exposed to asbestos. In addition, epidemiological studies conducted to date provide little convincing evidence of an association between asbestos in public water supplies and cancer. Therefore there is broad scientific consensus that asbestos does not present a significant risk of cancer by the route of ingestion.

1.5 SMOKING AND ASBESTOS FIBRES

The greatest cause of lung cancer is undoubtedly smoking tobacco. However, lung cancer also occurs among asbestos workers exposed to high levels of dust. This risk is significantly increased if the asbestos worker also smokes.

Many studies have shown a synergism of action between asbestos exposure and smoking. Therefore, all workers should be encouraged to stop smoking. While there is still some controversy, it is believed by many scientists that asbestosis is a necessary precondition for the development of lung cancer associated with asbestos.

1.6 THE THREE D'S OF FIBRE-RELATED DISEASE

The 1990's have seen significant advances in the understanding of mechanisms of fibre-induced disease. Today it is known that the risk of fibre related disease is determined by essentially 3 factors:

- **Dose** : the quantity of dust inhaled over time;
- **Dimension** : whether a material generates respirable dust; that is dust that contains fibres which are longer than 5 microns in length and less than 3 microns in diameter with an aspect ratio greater than 3 to 1; and,
- **Durability** : biopersistence of such dust in the human lung.

In general, long, thin, durable fibres are the most hazardous to health. Fibres shorter than 5 microns in length are not considered to present a health risk because of the ability of the body's natural defense mechanisms to deal effectively with contaminants of this size and nature.

All forms of asbestos fibres have been classified as Class I: "known human carcinogens", by the International Agency for Research on Cancer (IARC). However, there is an international scientific consensus that chrysotile is less hazardous than the amphibole varieties of asbestos. Not only is chrysotile a less dusty material because of its physical properties, it also has a tendency to break down and dissolve in body fluid and thus is more easily cleared from the lungs by natural defense mechanisms.

1.6.1 Biopersistence

Numerous studies over several decades relate to the importance of fibre dimensions (length and diameter) as prerequisites for biological potency, since these two parameters are related to respirability. However, more recent published evidence has come from investigations using modern techniques, in particular from mineral analyses performed on lung tissue, also known as "lung burden" studies. As a result, an additional parameter of fibrous materials is now universally recognized as of paramount importance for assessing the pathological potential of inhaled particles: **Durability**

- Durability is the characteristic that varies widely amongst different respirable particles;
- Durability is likely related to the different chemical structures and crystalline habits of mineral particles;
- Durability will determine the extent of a key biological phenomenon: **Biopersistence**

Biopersistence can also be described as a time period for inhaled particles to persist in the lungs before they are eventually dissolved or otherwise cleared.

Biopersistence studies have been carried out on a number of different respirable particles. It has become clear that there are vast differences among various respirable fibrous materials presently used by industry, ranging from very short persistence (low durability) to practically indefinite persistence (very high durability).

It is now generally agreed that adverse health effects are associated with fibres retained in the lung for long periods rather than with those that are cleared rapidly.

Regarding asbestos fibres, it was repeatedly demonstrated that chrysotile displays low biopersistence, as opposed to the amphibole asbestos fibre types displaying exceedingly long biopersistence. In addition, various types of glass fibres also have different solubility and biopersistence characteristics according to their respective manufacturing processes and chemical compositions. A similar observation was reported for refractory ceramic fibres (RCFs) and a series of man-made mineral fibres (MMMFs), from glass fibres to RCFs and natural fibres for in vivo durability.

Recent animal experiments, by Bernstein ***et al*** (see **Figure 1**) (2003 to 2006), performed according to the most stringent protocols recognized by the European Union show that soon after chrysotile fibres are inhaled, they are quickly cleared from the lungs. Amphiboles, which resist the acidic environment of the lungs, are not cleared as rapidly. The amphibole fibres remain in the lung for periods up to a year or more. These animal experiments provide robust support to the many epidemiological observations published in the past. They also support the more recent benchmark publication by Hodgson and Darnton (2000), showing that amphiboles are orders of magnitude more potent than chrysotile.

Thus it has become abundantly clear that biopersistence must now be taken into account when assessing risk associated with the use of respirable materials. Risk assessment and management of respirable fibrous materials must take into account not only the dimensions, but also the durability (or biopersistence) characteristics of all airborne materials used in industry. This should apply not only to the different asbestos fibre types, but also to all fibrous materials, whether natural or man-made.

Amphibole fibres, on the other hand, are more dusty materials as well as more durable and persist in the lung once inhaled. The increased potency of amphibole forms of asbestos as compared to chrysotile is corroborated by scientific studies.

1.7 CHRYSOTILE, ASBESTOS AND MESOTHELIOMA

Mesothelioma is a rare cancer of the membrane lining of the chest or abdominal cavities. The tumour typically develops 30 to 45 years after first exposure, and most often after exposure to blue or brown asbestos. For many years it was thought that exposure to asbestos was the sole cause of mesothelioma in man. However, extensive scientific reviews of this disease have concluded that up to 1/3 of the known mesothelioma cases have nothing to do with asbestos exposure. Human and animal studies show that causes or suspected causes of mesothelioma also include exposure to erionite, ionizing radiation, and various chemical substances. Based on a review of the scientific literature and close scrutiny of mesothelioma cases, there is broad consensus that mesothelioma is most likely to result from exposure to amphiboles.

1.8 IS THERE A THRESHOLD LEVEL FOR CHRYSOTILE?

There is ample human and animal evidence that at high and prolonged levels of exposure chrysotile could cause disease. The question that remains to be answered is whether or not there exists a threshold level of exposure below which there is no risk of disease as per other natural minerals such as silica, and metals such as nickel and copper.

In the case of asbestosis, there is broad consensus that a threshold level of exposure exists for chrysotile. Indeed, the Ontario Royal Commission on Asbestos (ORCA) in 1984, reached the following conclusion: "In our judgement, asbestosis will not occur in workers exposed to the regulated levels of occupational exposure now in force in Ontario (e.g. 1.0f/cc on an 8 hour time weighted average)", which was also the World Health Organization's (WHO) recommendation.

In the case of lung cancer, such broad consensus has not yet been reached, although there is now mounting human evidence pointing to the existence of a threshold. For example, a small number of epidemiological studies of workers exposed only to low levels of chrysotile have concluded that there was no statistically significant excess mortality resulting from chrysotile exposure (**Table 2**).

Because of the small number of studies involving exposure to chrysotile only, it is difficult to draw firm conclusions. However, in reviewing this and other data, a group of experts convened by the World Health Organization in April 1989, reached the conclusion that a level of control for chrysotile can be achieved, at which the lifetime risks of lung cancer and mesothelioma are very small. Subsequently, the Oxford meeting recommended an exposure limit of 1.0f/cc or below for chrysotile. It was also recommended that the use of crocidolite and amosite be banned as soon as possible.

A major study by McDonald et al. and published in 1997, gives further, but again not conclusive, evidence of the possible existence of a threshold for chrysotile. Based on an updated study of 11,000 workers, the authors found that "In each of the six classes of exposure up to 300 mppcf x years, the lung cancer SMR (Standard Mortality Ratio = observed mortality / expected mortality) was close to 1.3 (a total of 254 cases of lung cancer among 4,384 men, against 190.6 expected); there was no evidence of a trend". 300 mppcf x years **is equivalent to about 1,000 fibre years or 50f/cc for 20 years of exposure**. According to McDonald, "The significance of this study is that any deaths from asbestosis or lung cancer arising from current occupational exposure levels are most unlikely."

Therefore, despite mounting evidence, there is not as yet broad scientific consensus of a threshold level of exposure for chrysotile. What is clear is that, at present levels of occupational exposure, if there are risks, they are exceedingly small.

TABLE 2 - HUMAN STUDIES SUPPORTING A THRESHOLD FOR CHRYSOTILE

Churg A. Lung. ***Asbestos content in long-term residents of a chrysotile mining town.*** American Review of Respiratory Disease, 1986, 134(1): 125-127.

Study comparing health effects in residents of chrysotile mining town, where levels are from 200 to 500 times higher than in most North American cities (e.g. 0.08f/cc in 1973). In spite of higher levels, no evidence of higher asbestos-related disease was found.

Newhouse, M.I., and Sullivan, K.R., ***A mortality study of workers manufacturing friction materials: 1941-86.*** British Journal of Industrial Medicine, 1989, 46(3): 176-179

The authors confirm that there was no excess mortality from lung cancer, other asbestos-related tumours or chronic respiratory disease (e.g. at exposure levels averaging between 0.5 and 1.0 f/cc).

Ohlson, C.G. and Hogstedt, ***C., Lung cancer among asbestos cement workers; A Swedish cohort study and review.*** British Journal of Industrial Medicine, 1985, 42(6): 397-402.

A cohort study of 1176 asbestos-cement workers in a Swedish plant using chrysotile asbestos found no excess mortality at exposures of between 10-20 f/ml years.

Thomas, H.F., Benjamin, L.T., Elwood, P.C. & Sweetnam, P.M., ***Further follow-up study of workers from an asbestos-cement factory.*** British Journal of Industrial Medicine, 1982, 39(3): 273-276.

A follow-up study of 1,970 workers in an asbestos-cement factory using chrysotile only, at low levels of exposure, showed no significant Standard Mortality Ratio (SMR) excesses. The causes of death investigated included neoplasms and cancers of the lung, pleura and gastrointestinal tract.

Weill, H., Hughes, J. and Waggenspack, C., ***Influence of dose and fibre type of respiratory malignancy risk in asbestos-cement manufacturing.*** American Review of Respiratory Disease, 1979, 120(2): 345-354

An investigation of 5,645 asbestos-cement manufacturing workers found no increased mortality resulting from chrysotile exposures of approximately 15 f/ml years.

Camus, M., Siemiatycki, J., Case, B. W., Desy, M., Richardson, L., and Campbell, S.(2002). *Risk of mesothelioma among women living near chrysotile mines versus USEPA asbestos risk model: Preliminary findings.* Ann. Occup. Hyg. 46(suppl. 1):95–98.

Camus et al. (2002) found that such model estimates as used by the EPA appear to overestimate the actual risks by a factor of 10–100 and, at very low doses, may well be predicting risks that are not present due to the existence of a practical, if not real, threshold.

Camus M, Siemiatycki J, and Meek B (1998) *Nonoccupational exposure to chrysotile asbestos and the risk of lung cancer.* N. Engl. J. Med., May 28, 1998; 338(22): 1565-71.

The authors conclude: "We found no measurable excess risk of death due to lung cancer among women in two chrysotile-asbestos-mining regions. The EPA's model overestimated the risk of asbestos-induced lung cancer by at least a factor of 10."

Hodgson JT and Darnton A (2000) Ann. Occup. Hyg. 44 (8) 365-601. *The Quantitative Risks of Mesothelioma and Lung Cancer in Relation to Asbestos Exposure.*

A series of quantified risk summary statements for different levels of cumulative exposure to asbestos types are presented.

Gardner, M.J., Winter, P.D., Pannett, B. and Powell, C.A. (1986). *Follow up study of workers manufacturing chrysotile asbestos cement products.* British Journal of Industrial Medicine 43:726-732.

A cohort study carried out on 2,167 subjects employed between 1941 and 1982. No excess of lung cancers or other asbestos-related excess death is reported, at mean fibre concentrations below 1 f/ml, although higher levels had probably occurred in certain areas of the asbestos-cement factory.

Paustenbach D.J., Finley B.L., Lu E.T., Brorby G.P., and Sheehan P.J. (2004). *Environmental and occupational health hazards associated with the presence of asbestos in brake linings and pads (1900 to present): A 'state-of-the-art review'.* J Toxicol Environ Health, Part B 7: 33-110.

This is a review and update covering several decades, of studies regarding the risk associated with the use of asbestos in the fabrication of friction materials and generally its use in the automobile service industry. The authors indicate that in general, the exposure levels were very low, and no excess risk appeared when only chrysotile was used. The rare situations where a potential risk was identified related to the use of amphibole fibres.

Yarborough C.M. (2006). Chrysotile as a Cause of Mesothelioma : *An Assessment Based on Epidemiology.* Critical Reviews in Toxicology 36: 165-187

This exhaustive review concerns cohort studies undertaken to evaluate data on chrysotile, taking into account the possible contribution of various factors, such as the types of asbestos used (amphiboles), the exposure levels observed and the relative uniformity of the results. The examination of the studies, on 71 cohorts, where a threshold for chrysotile was used, does not support the hypothesis that chrysotile, in the absence of contamination by amphiboles, could cause mesothelioma.

L. Sichletidis, D. Chloros, D. Spyratos, A.-B. Haidich, I. Fourkiotou; M. Kakoura, and D. Patakas (2008). *Mortality from occupational Exposure to Relatively Pure Chrysotile: A 39-Year Study.* **Respiration, Published Online: October 9, 2008. http://content.karger.com/ProdukteDB/produkte.asp?Aktion=AcceptedPapers&ProduktNr=224278**

An investigation covering a span of almost 40 years on the mortality rate among workers exposed to relatively pure chrysotile in an asbestos cement factory that opened in 1968, in Greece. The factory used approximately 2,000 tonnes of chrysotile annually until 2005. Fibre concentration was measured regularly, and was always below permissible levels. Date and cause of death were recorded among all active and retired workers. No case of mesothelioma was reported. Overall mortality rate was significantly lower than that of the Greek general population. Conclusions of the authors: "Occupational exposure to relatively pure chrysotile within permissible levels was not associated with a significant increase in lung cancer or with mesothelioma."

1.9 OCCUPATIONAL RISKS

The risks to workers at recommended exposure levels of 1.0f/cc have been estimated by a number of scientific bodies. For example, the ORCA Commission estimated that there would be a 1 in 4 chance of 1 premature death amongst the 1200 workers engaged in chrysotile product manufacturing (excluding textiles) a risk level equivalent to that faced by workers in general manufacturing in Ontario.

Similar conclusions were reached by a group of experts convened by the WHO at Oxford, England, in April 1989. In short, WHO predicted lifetime risks under a 1f/cc chrysotile standard for non-smokers for both mesothelioma and lung cancer would be approximately 2 in 40,000 or 0.05 in 1,000.

The risk estimates contained in both the ORCA and WHO Oxford reports were based on a linear dose-response curve. However, a paper by Liddell published in 1997 concludes that at low levels of exposure for chrysotile, the dose-response curve is more likely to be sub-linear thus rendering risk estimates based on a linear dose-response curve to be seriously overstated.

The risk to workers exposed to chrysotile at present occupational exposure levels and under controlled conditions is therefore extremely low if one is to be found at all. Very few industrial sectors can offer such a safe working environment (**Table 3**). This underscores the point that a well controlled chrysotile product industry can be a model for most other industrial sectors.

1.10 ENVIRONMENTAL RISKS

In recent years, public attention has shifted from workplace to general environment and population issues and concerns. This was driven by the simplistic view that one (1) fibre can kill. And, since there is no evidence of a threshold, the general public was believed to be at risk. This has led to pressure on regulatory authorities to ban all types and applications of asbestos.

Our lungs treat an average of 8 to 10 litres of air per minute. If we take the 10 litres/minute breathing rate of a human being, we get a lung ventilation volume of 14,400 litres of air breathed daily (10 l/min x 60 min x 24 hrs). Until now, no public organizations in the world evaluate the quantity of natural fibres that individuals breathe daily.

If asbestos concentration in the air is 0.001 f/ml, i.e. 1 f/l, **we breathe daily 14 400 asbestos fibres**, besides numerous other man made and natural fibres (fibreglass, textile fibres, etc) normally existing in the ambient air and that, without detectable problems.

Another concern is the asbestos fibre concentrations in drinking water. Many studies have been conducted on the presence of fibre in drinking water such as the monograph by B. T. Commins and published in 1983, which reviewed the situation and permitted to conclude that risks associated with asbestos ingestion were low.

TABLE 3 - RISK OF WORK-RELATED DEATH, ALL CAUSES, IN SELECTED INDUSTRIES…

RISK OF WORK-RELATED DEATH, ALL CAUSES, IN SELECTED INDUSTRIES 1983, 1984/85 (USA)

INDUSTRY	LIFETIME DEATH RATE/1000		
Mining	2.4	to	18.6
Construction	10.3	to	11.8
Transportation and Public Utilities	6.0	to	7.6
Agriculture	5.7	to	7.3
Manufacturing	1.9	to	2.0
Wholesale and Retail Trade	1.4	to	1.5
Services	1.0	to	1.8
Finance, Insurance, Real Estate	0.8	to	0.9
Total Private Sector	2.5	to	6.9

Source: Testimony presented by G.C. Wrenn of Environ Corporation to U.S. EPA (1986).

According to the report of the Ontario Royal Commission on Matters of Health and Safety Arising from the Use of Asbestos, asbestos fibres are found in beverages we all drink. (**Table 4**– Asbestos Fibre Concentrations in Beverages and Water – Millions of Fibres / litre)

TABLE 4 - ASBESTOS FIBRE CONCENTRATIONS IN BEVERAGES & WATER

ASBESTOS FIBRE CONCENTRATIONS IN BEVERAGES AND WATER		MILLION FIBRE PER LITER
Beer	Canadian 1	4.3
Beer	Canadian 2	6.6
Beer	U.S.A. 1	2.0
Beer	U.S.A. 2	1.1
Sherry	Spanish	4.1
Sherry	Canadian	2.0
Sherry	South Africa	2.6
Port	Canadian	2.1
Vermouth	French	1.8
Vermouth	Italian	11.7
Soft Drink	Ginger Ale	12.2
Soft Drink	Tonic Water I	1.7
Soft Drink	Tonic Water II	1.7
Soft Drink	Orange	2.5
Tap Water	Ottawa, Ont. Ottawa River (*)	2.0
Tap Water	Toronto, Ont., Lake Ontario (*)	4.4
Tap Water	Montreal, Qc, St-Lawrence River	2.4
Tap Water	Hull, Quebec (Qc), Ottawa River (**)	9.5
Tap Water	Beauport, Qc, St. Lawrence River (6 km below Quebec City)	8.1
Tap Water	Drummondville (Eastern Townships) Quebec, Nicolet River(*)	2.9
Tap Water	Asbestos (Eastern Townships) Qc, Nicolet River (*)	5.9
Tap Water	Thetford Mines, (Eastern Townships) Qc, La à la Truite (**)	172.7
Melted Snow	Ottawa, top 30 cm (2-3 weeks precipitation)	33.5
River Water	Ottawa River, at Ottawa	9.5

NOTES (*) Filtration Plant (**) No Filtration Plant Used
SOURCE Hugh M, Cunningham and Roderic D. Pontefract "Asbestos Fibres in Beverages and Drinking Water," Nature (London) 232 (30 July 1971): 332

Common sense is slowly taking control of events. This has been due to a number of realizations. First, since chrysotile is ubiquitous in the earth's crust, there is little man can do to control sources of exposure from naturally occurring sources. Secondly, studies have shown that airborne concentrations inside buildings containing asbestos products do not differ significantly from levels in air outside buildings. Moreover, these levels are very low (e.g. less than 0.001f/cc). Therefore, if there are risks to the general population, they are very low (lifetime risks less than 1 in 100,000) and much smaller than the risks we face in everyday life (see **Table 5**).

A meeting on the Environmental Reduction of Asbestos, convened by the WHO in Rome in 1988, concluded that high density products, such as asbestos-cement and friction materials, do not present unacceptable risks to the general population, although care is needed to contain airborne dust during installation and repair. The meeting also recommended that the use of friable insulation materials containing asbestos should be strongly discouraged on a worldwide basis.

TABLE 5 - RELATIVE RISKS OF EVERY DAY ACTIVITIES ESTIMATES OR RISK FROM VARIOUS CAUSES …

(MAINLY U.S. DATA)*

(Proceedings Symposium on Aspects of Exposure to Asbestos in Buildings, Harvard University, December 1989)

Cause	Voluntary [V] or Involuntary [I]	Lifetime Risk of Premature Death (per 100,000)
Smoking (all causes)	V	21,900
Smoking (cancer only)	V	8,800
Motor Vehicle	I	1,600
Frequent Airline Passenger	V/I	730
Coal Mining Accidents	I/V	441
Indoor Radon	V/I	400
Motor Vehicle – Pedestrian	I	291
Environmental Tobacco Smoke/Living with a Smoker	I/V	200
Diagnostic X-rays	I	75
Cycling Deaths	I/V	75
Consuming Miami or New Orleans Drinking Water	I	7
Lightning	I	3
Hurricanes	I	3
Asbestos in School Buildings	I	1

(*) Sources of Risk Estimates: Commins (1985), Weill & Hughes (1986), Wilson & Crouch (1982)

Thirdly, except for crocidolite, there is no epidemiological evidence demonstrating a general population risk from environmental asbestos. Indeed, quite the contrary. Several epidemiological studies show no evidence of higher asbestos-related disease amongst the general population of Quebec chrysotile asbestos mining communities compared to other North American cities, despite exposure levels 200 - 500 times higher!

Environmental risks of asbestos have been studied in a number of major scientific bodies. For example, at the WHO Conference on Mineral Fibres in the Non-occupational Environment in Lyon in September 1987, it was concluded by a Group of Experts that for the general population, the risks of mesothelioma and lung cancer, attributable to asbestos, are probably undetectably low. The risk of asbestosis is virtually zero.

Regarding asbestos-cement pipes for potable water distribution systems, the WHO has concluded that the concentrations of asbestos in drinking water resulting from the use of asbestos-cement pipes do not present a hazard to human health. Based on its ongoing evaluation of scientific findings in the field of drinking water quality, the WHO stated in the 1993 edition of its annual Guidelines for Drinking Water Quality, that "asbestos is a substance not of health significance at concentrations normally found in drinking water". The WHO found "no convincing evidence of the carcinogenicity of ingested asbestos in epidemiological studies of populations with drinking water supplies containing high concentrations of asbestos". An extensive review of animal studies which support the epidemiological data, led the WHO to conclude that "there was no need to establish a health-based guideline value for asbestos in drinking water".

The WHO conclusions are in line with a long list of agencies and scientific committees which have concluded that ingested asbestos is not a health hazard. In a 1991 news release, the U.S. EPA noted that "asbestos is not classified as carcinogen in the regulations because EPA has determined it is a carcinogen only when inhaled, not ingested". In 1989, the Canadian Government concluded in its Drinking Water Quality Guidelines that "there is no consistent, convincing evidence that ingested asbestos is hazardous. There is, therefore, no need to establish a maximum acceptable concentration for asbestos in drinking water".

These and other pronouncements by national and international water control agencies should remove any remaining doubts about asbestos in drinking water posing a health hazard.

1.11 FRIABLE ASBESTOS INSULATION IN BUILDINGS

In North America, the policy debate over management versus immediate universal removal of in-place friable asbestos insulation materials, was effectively concluded in September 1990, following the publication of the U.S. EPA Green Book, entitled "Managing Asbestos In Place". Consistent with many scientific reviews on the subject, it is now generally agreed that intact, undisturbed asbestos-containing materials, generally do not pose a health hazard. Therefore, unless ACMs are in poor condition or located where they can be easily disturbed, the best approach is to manage the problem and defer removal until the time of major renovation or demolition of a building.

This conclusion is based on **EPA's 5 facts**:

1. Although asbestos is a hazard, the risk of asbestos-related disease depends upon exposure to airborne asbestos fibres.

2. Based upon available data, the average airborne asbestos levels in buildings seem to be very low. Accordingly, the health risk to most building occupants also appears to be very low.

3. Removal is often not a building owner's best course of action to reduce asbestos exposure. In fact, improper removal can create a dangerous situation where none previously existed.

4. EPA only requires asbestos removal in order to prevent significant public exposure to airborne asbestos fibres during building demolition or renovation activities.

5. EPA does recommend a proactive, in-place management program whenever asbestos-containing material is discovered.

1.12 OTHER NATURAL AND MAN-MADE FIBRES

The health hazards related to the exposure to fibrous materials other than chrysotile are attracting increasing attention from both the international scientific community and health agencies. Mounting scientific evidence as well as recent international regulatory developments underscores the soundness of these concerns.

In the U.S., fibreglass has been listed by the Department of Health and Human Services as a substance "reasonably anticipated to be a carcinogen". Refractory ceramic fibre (RCF) has also been listed as a "probable human carcinogen", and concerns have been raised regarding the health effects of silicon carbide whiskers used in composite materials. In Germany, the MAK Commission, the agency responsible for producing an annual list of hazardous substances, has classified ceramic fibre as "a substance with known carcinogenic potential in humans," and listed other man-made mineral fibres, such as glass fibre and mineral wool, under a new category, "to be treated as if a probable cause of cancer". Slag wool is defined as "possibly carcinogenic".

Canadian authorities have reached similar conclusions for refractory ceramic fibre, which has been classified as "probably carcinogenic to humans", and rock/slag wool which have been identified as "possibly carcinogenic to humans". However their position regarding fibreglass differs -Health Canada considers it unlikely that fibreglass is carcinogenic to humans.

Another report on selected synthetic organic fibres published in 1993 by the International Programme on Chemical Safety, a World Health Organization affiliate, concluded that all organic fibres that are respirable and durable are of potential health concern. The report recommended that, "exposures to these fibres should be controlled to the same degree as that required for asbestos until data supporting a lesser degree of control become available - and that the available data suggest that para-aramid fibres fall within this category."

1.12.1 ILO Group of Experts Meeting

In April 1989, the International Labour Organization convened a Group of Experts meeting on Safety in the Use of Mineral and Synthetic Fibres. The meeting concluded that long, thin, durable fibres appear to be most hazardous to health and that in all cases the objective should be the reduction of human exposure to airborne respirable fibres.

In 2001... ILO concluded that there is a lack of studies available on MMMFs regarding their health effects on man. They also provided general advice on appropriate preventive and control measures for work with man-made mineral and synthetic fibres, including exposure limit values for total dust and respirable fibre concentrations, labelling, work practices, including engineering controls, housekeeping and personal protective equipment, monitoring of the workplace environment, health surveillance of workers and instruction, training and information for workers. It was also recommended that a Code of Practice on Insulation Wools be developed on a priority basis.

1.12.2 All Fibres Are Not Equally Hazardous

As in the case of the asbestos family of fibres, it appears that not all man-made fibres are equally hazardous. Again the 3 D's - Dose, Dimension and Durability (biopersistence), must be applied in determining the health risks of various fibrous substances.

To illustrate, a conference was held by WHO/IARC (1992) on "Biopersistence of Respirable Synthetic Fibres and Minerals". Data presented at the Symposium showed that various types of glass fibres also have different solubility and biopersistence characteristics, which may vary according to their respective manufacturing process and chemical composition. Thus, glass fibres with high Aluminum (Al) content were shown to be more durable than those with low Al content. The same observation has been made with respect to refractory ceramic fibres (RCF), where it was found that a high Al_20_3 content has a negative influence on biosolubility, whereas high concentrations of alkaline oxides have the opposite effect. A major study by German scientists of the Fraunhofer Institute in Hannover compared a whole series of MMMFs (from glass to RCFs) and natural fibres for in vivo durability (see **Figure 1**). Half-times for fibre elimination from the lung ranged from 10 to 500 days. Another study from the USA also reported that inhaled RCFs showed no chemical alterations 2 years following end of exposure, whereas glass fibres showed that some components had leached. Another study from the Institute of Occupational Medicine in Edinburgh showed that, in experiments using rats, chrysotile asbestos and glass fibres were cleared at approximately the same rate, whereas there was very little clearance of crocidolite asbestos.

The general conclusion from this International Symposium, which was held in September 1992, is that RCFs are certainly not cleared rapidly from the lung; some MMMFs are cleared much more slowly than others; and, the same is true for asbestos fibre types, where it is recognized that amphiboles, in particular crocidolite and amosite have clearance half-times in the range of decades, whereas chrysotile is cleared more much more quickly.

Based on the ***durability*** factor alone, the most recent data available point to the existence of a biopersistence for pathological potential for all respirable fibres, natural and man-made, from very low potential (highly soluble, short biopersistence) to very high potential(low solubility, long biopersistence) (see **Figure 2**).

1.13 A FINAL COMMENT

At high and prolonged levels of exposure, chrysotile can present potential risks to worker health. However, there is broad scientific consensus that provided they are properly controlled and used, chrysotile and its modern day products do not pose risks of any significance to public or worker health and the general environment. A majority of countries around the world share this view.

However, while the philosophy of controlled-use is one thing, practical reality is quite another. To reinforce confidence in controlled-use as an appropriate regulatory approach, the international chrysotile industry must demonstrate in a very clear and visible fashion that chrysotile and its modern day products are being properly handled and used, not only in factories, but on a product life-cycle basis. Without such demonstrations, science holds little importance.

FIGURE 1- BIOPERSISTENCE – COMPARATIVE DATA

Typical comparison for T ½ clearance for different fibre types

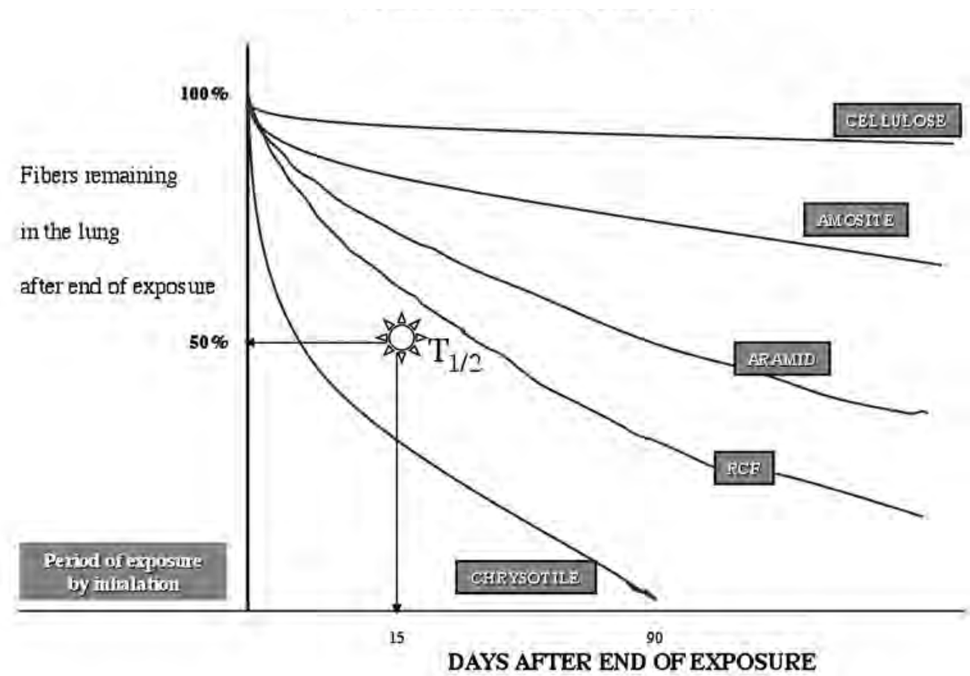
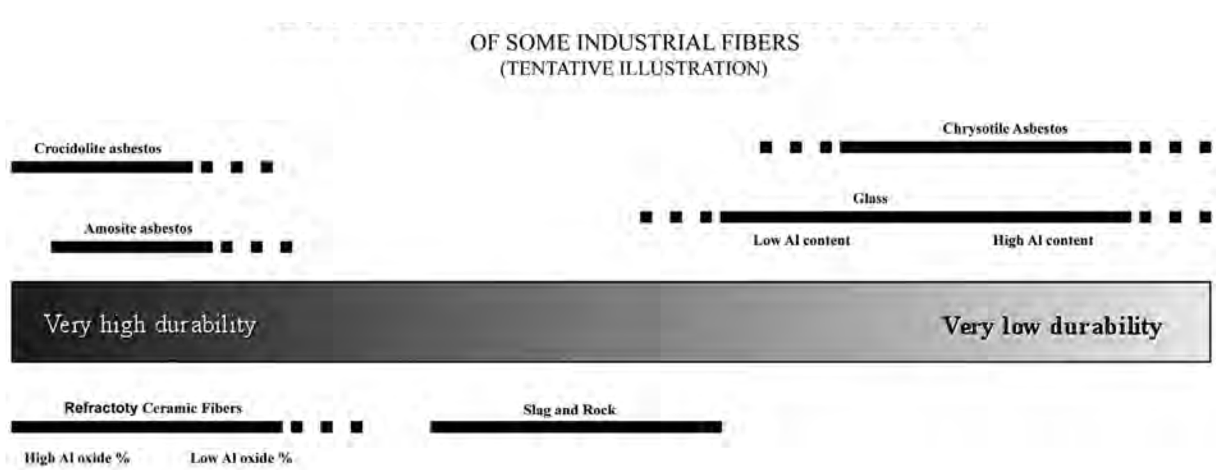


FIGURE 2- CONTINUUM OF IN VIVO DURABILITY



2

Commitment and Responsibilities

2. Commitment and Responsibilities

INTRODUCTION

Chrysotile has been proven to be a highly valuable industrial material. Its products and applications have significantly enhanced living standards worldwide. However, its past misuse and mishandling has, to some extent, overshadowed its many benefits. Today, workers, customers, governments and environmental activists have made it very clear that companies that use chrysotile must be responsible for the safe use and disposal of their products.

Chrysotile has not been singled out for special attention in this respect. All industries, which produce or use substances which could present risks to public or worker health and the general environment, have come to understand that health, safety and the environmental impact of their activities and products have to be carefully monitored and controlled.

Product stewardship is a term used by producers and manufacturers to describe the various activities designed to provide users with specific information on possible hazards and inform them of the ways in which their products should be used without undue health, safety and environmental risks. The scope of product stewardship must embrace the entire life cycle of a product or process from initial research and development to manufacture, use and ultimate disposal or recycling.

2.1 ILO CONVENTION 162

ILO Convention 162 *Safety in the Use of Asbestos* indicates clearly the responsibilities of employers when using asbestos or handling asbestos products. They establish the baseline of any corporate or industry product stewardship or preventive and control program and include the following:

- Participate, consult and cooperate with government and workers' organizations to give effect to national regulations;
- Comply with national regulations;
- Establish a prevention program with the participation of workers;
- Implement engineering controls to prevent exposure;
- Reduce exposure to as low a level as is reasonably practicable;
- Establish procedures to deal with emergency situations;
- Establish written procedures for the training of workers;
- Complete information about the health hazards related to work;
- Measure airborne concentrations of fibres and inform the workers and inspectors;
- Arrange for medical examinations at no cost to the worker;
- Full disclosure to the worker of the results of examinations;
- Notify government of certain types of work involving chrysotile;
- Adequately label the container or the product;
- Provide respiratory equipment and protective clothing;
- Safe disposal of waste and prevention of pollution;
- Provide material safety data sheets to all users of chrysotile fibres and chrysotile products.

2.2 SENIOR MANAGEMENT: THE BUCK STOPS HERE

Senior management is ultimately responsible for ensuring that the above measures are taken. The most important first step is a conscious commitment to establish a preventive and control program and to provide continued guidance and resources.

Commitment means a pledge to respect the health and well-being of others. Management must take firm action in stating its intentions and making them known to all employees. There should be a short statement from the competent authority of your company addressing the dust control issues and stating what actions will be taken. Chrysotile producers, located in Québec, Canada, made this commitment several years ago and reconfirmed it recently. Copies of their statements are attached (see **APPENDIX 1**).

As well, a letter should be circulated among all employees, clearly identifying goals to be achieved and a schedule for realizing these goals. Furthermore, management must be willing to commit resources to achieve the goals it has set forth.

To achieve the goals, management and employees must agree to work together in improving safety and health conditions. Employees must participate and become an integral part of improving safety and health conditions. They must also show their willingness to cooperate and their adaptability towards improving the work environment.

2.2.1 Keys to Success

Success of an effective environmental program depends on management challenging itself and the employees recognizing the benefits that all should receive. It should be a partnership in pooling each other's abilities toward a common goal. That means management and employees should set attainable objectives that can be extended as work progresses.

2.2.2 Senior Management

Senior Management is responsible for any deterioration of stated policies. If they do not take immediate action to correct situations, they are at fault since it is in their power to correct the situation.

Management, at any level, should intervene immediately when it sees an incorrect practice by an employee, thus showing the importance of working safely. This involvement by senior management should not be in a punitive manner but as a teaching aid to employees, thus improving relations and assisting employees in recognizing the importance of safety.

2.2.3 Administrative Systems

The president should delegate the responsibilities relating to the preventive and control program to a senior manager. This manager should have full access to information, such as monitoring results, risk assessments, reports, etc.

A committee for safety and hygiene should be established and include representatives from management and the employees. This committee for safety and hygiene should give particular attention to the health risks related to the use of chrysotile.

Periodical meetings (monthly) of the committee should be organized and should be the occasion for a frank and complete interchange of information and consultation in regards to:

1. The nature of the potentially harmful fibres to which the employees are exposed and the risks associated with such exposure;
2. The results of workplace monitoring;
3. The protective measures that should be adopted;
4. The results of audits in the factory; and
5. Itemized area of concern with intended action to correct or analyze further.

2.2.4 Education and Training

In order for an employee to act preventively against the potential risk related to chrysotile and follow adequate personal protective measures, he/she should receive ample information and training.

The method to be used for the transfer of information should include the written as well as the verbal form, and the language used should be familiar to all employees.

Rigorous supervision should be maintained until new employees are fully trained. The above also applies to employees who have been assigned to a new workplace.

The training should contain at least the following main points:

1. Potential hazards caused by chrysotile dust;
2. Smoking as a potential single risk factor;
3. General preventive measures;
4. Behaviour in the workplace where exposure to chrysotile might occur;
5. Workplaces and jobs requiring special protection measures;
6. Adequate behaviour in emergency situations / circumstances where special protective measures are necessary;
7. Individual and collective protection equipment;
8. The correct use of vacuum cleaning, laundry, changing rooms and eating area;
9. Correct use of approved respirators for asbestos dust;
10. Importance of regular medical check-ups;
11. Need to comply strictly with the guidelines on the controlled-use of chrysotile;
12. Meaning of the illustrative and written signs.

2.2.5 Systematic Approach to Development, Implementation and Monitoring

Prevention and control should be viewed in a systematic approach by:

1. Defining problem areas (monitoring)
- Established monitoring strategy
- Workplace monitoring static sampling
- Workplace monitoring personal sampling

2. Search for causes and ways to solve problems (development)
- Cleaning facilities
- Preventive maintenance of equipment
- Vacuum cleaning equipment
- Prevention program
- Projects
- Information gathering

3. Prepare program of implementation in stages
• Training
• Personal protection measures
• Preventive measures
• Procedures when the workplace limit value is exceeded
• Step-by-step control of area.

There should be no altering of data, and employees are entitled to know the real level of exposure and management's plan to correct the problem areas. On the other hand, management needs to know all the facts and employees have a responsibility to cooperate fully.

2.3 OUTREACH PROGRAMS FOR CUSTOMERS AND USERS

Corporate responsibility for prevention and control does not stop at the plant gate. Companies manufacturing chrysotile containing products are obliged, at a minimum, to label their products and provide a material safety data sheet. The label must conform with national requirements and at a minimum those set-out in the ILO Code of Practice "*Safety in the Use of Asbestos*":

- *All asbestos-containing products should have an internationally recognized warning symbol designating the product as asbestos-containing and warning the user that inhalation of asbestos dust may cause serious damage to health.*
- *All material to be used on site and containing asbestos should be labelled in such a way as to alert the user to the potential health hazards involved and to the appropriate precautions to be taken.*

2.3.1 Material Safety Data Sheet (MSDS) (see APPENDIX 2)

MSDS should contain the following information:

1. The name of the product;

2. The name and the address of the producer;

3. The type of fibre contained;

4. The health risks, including the dangerous properties of the fibre;

5. Detailed procedures to clean and eliminate without risk any fibre that might have escaped or been spilled, inclusive of the labelling and the adequate disposal procedures of containers with waste and contaminated materials;

6. The requirements for the personal protection equipment;

7. Precautions to be taken with the handling of the product.

Most corporate or industry product stewardship programs go well beyond these minimum requirements. For example, detailed safety instructions, complete with pictogrammes, should accompany chrysotile-based products whenever they are sold (see **APPENDIX 3**). Active lines of communication should be established with distributors and users to ensure that they are aware of the safety precautions to be taken. In the case where installation and removal is undertaken by contractors, periodic training and/or qualification sessions should be organized to promote the use of safe tools, work practices and proper waste disposal methods.

In conclusion, everyone shares in the responsibilities and commitment to bring about an effective program for prevention and control. Cooperation is the key to success.

2.3.2 Memorandum of Understanding (MOU)

The policy is a voluntary initiative of the signatory producers and users of chrysotile. It is based on the recognition and acceptance of principles set out in Convention 162 and the Code of Practice of the International Labour Organization (ILO) concerning safety in the use of asbestos. The objective of responsible use is to supply chrysotile only to companies which comply with the national occupational health regulations or which have submitted action plans and formal commitments, in writing, with a view to bring their activities in line with such regulations.

The industry is convinced that, if all facilities producing and consuming chrysotile comply with the international industrial hygiene standards, chrysotile can continue to contribute to the development of society by providing affordable materials for the construction of housing, pipes to supply potable water and many other uses for these durable products. The chrysotile producers continue to offer technical support and advice to all stakeholders. The combined efforts of workers and their respective labour organizations, governmental authorities and the chrysotile producers have made it possible to establish rules and regulations for the responsible use of chrysotile.

APPENDIX 1 - SAFETY, HEALTH, INDUSTRIAL HYGIENE, JEFFREY MINE, SÉCURITÉ, SANTÉ, HYGIENE INDUSTRIELLE, MINE JEFFREY

Translation of original french text

MINE JEFFREY INC.

SAFETY HEALTH INDUSTRIAL HYGIENE

Our corporate mission is to assure the economical continuity of Jeffrey Mine.

To reach this corporate objective, the integrity of our human resources must be the first priority. After, will automatically come the productivity and the quality of life…

Safety, Health and Industrial Hygiene are the common responsibilities of all the workers including management of our company. Our paritarism is the key to our success.

The main goals being the accident prevention supported by mutual efforts to improve the safety of our working sites, the perpetual surveillance of our working conditions and ultimately the insurance that all of us workers, unionized or staff, are treated with great humanity in case of an accident.

March 2009

G.B. Coulombe
Président, directeur général

APPENDIX 1 - HEALTH AND SAFETY POLICY AT WORK, LAB CHRYSOTILE

LAB CHRYSOTILE

HEALTH AND SAFETY POLICY AT WORK

LAB considers health and safety at work equal in importance to personnel management, production, the quality of products and competitiveness of the enterprise.

LAB adopts the objective of protecting its employees from accidents and professional illness.

LAB strives to eliminate or minimize dangerous conditions at the source and to conform to effective standards to protect employees.

LAB continuously informs its employees of the inherent dangers of the operations and trains its employees in using safe working methods.

Management and personnel must be dedicated to respecting regulations and implementing safe working methods.

Each member of the organization bears the responsibility of his own safety and must contribute towards the prevention of accidents in the workplace.

Simon Dupéré
President &
Chief Executive Officer

March 2009

LAB Chrysotile

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APPENDIX 2 - MATERIALS SAFETY DATA SHEET (MSDS): JEFFREY MINE

MINE JEFFREY Inc.
2, Du Carmel Street
P.O. Box 450
Danville (Quebec)
Canada J0A 1A0

Tel: (819) 879-6000
Fax: (819) 879-2000

Chrysotile

Asbestos Fibre
Material Safety Data Sheet

SECTION I - PRODUCT IDENTIFICATION		
• **Name:** chrysotile asbestos	• **Chemical family:** fibrous hydrated silicates	
• **Synonym:** asbestos, white	• **Formula:** $Mg_3(Si_2O_5)(OH)_4$	• **M.W.:** ca 283
• **CAS Registry Number:** 12001-29-5	• **EPA Code Designation:** A-152-4672	• **UN No.:** 2590
• **WHIMS Classification:** D2A	• **EEC No:** 650-013-00-6	
SECTION II - HAZARDOUS INGREDIENTS		
• **Chrysotile asbestos** (95%-98%)	• **Threshold Limit Value:** 0.1-2.0 f/ml (see the countries regulations)	
• **Magnetite,** Fe_3O_4 (0.5-5%)	• **Threshold Limit Value:** 5 mg/m^3 (respirable)	
SECTION III - PHYSICAL DATA		
• **Physical state:** solid	• **Appearance:** White, Fibrous	• **Odor:** none
• **Specific gravity:** 2.4 - 2.6	• **Solubility in water:** insoluble	• **pH ~ 10**
• **Boiling point:** not applicable	• **Melting point:** will dehydrate above 580°C	
• **Vapour pressure:** not applicable	• **Evaporation rate:** not applicable	• **Percent volatile:** not applicable
SECTION IV - FIRE AND EXPLOSION HAZARD DATA		
• **Flammability:** non-flammable	• **Explosion sensibility:** no explosion hazard	
• **Flash point:** not applicable	• **Combustibility:** non combustible	
SECTION V - REACTIVITY DATA		
• **Stability:** very stable	• **Incompatibility (material to avoid):** none	
• **Hazardous decomposition:** not applicable	• **Hazardous polymerization:** not applicable	
SECTION VI - HEALTH HAZARD DATA		
• **Route of entry:** inhalation		
• **Acute effects:** no immediate reaction to overexposure		
• **Chronic effects:** long term overexposure may cause asbestosis and increase the risk of lung cancer.		
• **Toxic effects:** listed as a carcinogen or potential carcinogen/NTP-OSHA-IARC		
• **Ingestion:** not hazardous		
• **Eye contact:** inert dust, may cause irritation.		
• **Skin contact:** inert dust. It is not absorbed. Remove chrysotile slivers.		

SECTION VII - PREVENTIVE MEASURES
• **Personal protection:** use respirators in accordance with Article 15 of the Convention 162 adopted by the International Labour Conference, Geneva, June 24, 1986.
• **Ventilation:** local exhaust system and/or high efficiency particulate air (HEPA) dust collection to within Threshold Limit Value (TLV).
• **Other protective equipment:** when risks of excessive concentration, use special clothing and protective • equipment in accordance with Articles 15 and 18 of the Convention 162 adopted by the International Labour Conference, Geneva, June 24, 1986.
• **Handling and storage:** maintain good housekeeping practices. Clean waste with HEPA vacuum cleaner and place in closed containers. Avoid inhalation of dust.
• **Spill and leak procedure:** HEPA vacuum clean spillage. Repair the leaks. If sweeping is necessary, wet down spillage. Use approved respiratory and protective equipment.
• **Waste disposal method:** disposal of waste in accordance with Article 19 of the Convention 162 adopted by the International Labour Conference, Geneva, June 24, 1986.
• **Other precautions:** Sustained high level exposure to Chrysotile, in conjunction with smoking, is thought to increase the risk of lung cancer. See danger and handling label on the bag.

SECTION VIII - FIRST AID MEASURES
• **Inhalation:** no acute effect of exposure. Avoid breathing excessive dust when handling, dumping and mixing.
• **Eyes:** inert dust. Remove the dust which may cause irritation.
• **Skin:** inert dust. Clean with water.

SECTION IX - PREPARATION DATE	
• **Date prepared:** March 03, 2008	• **Previous edition:** August 15, 2005
• **Phone number:** (819) 879-6000	• **Fax number:** (819) 879-2000
• **Prepared by:** Technical Services Department	

• Mine Jeffrey Inc. believes that such information is accurate and reliable as of the date of this material safety data sheet, but no representation, guarantee or warranty, expressed or implied, is made as to the accuracy, reliability, or completeness of the information. Mine Jeffrey Inc. urges persons receiving this information to make their own determination as to the

APPENDIX 2 - MATERIALS SAFETY DATA SHEET (MSDS): LAB CHRYSOTILE

LAB CHRYSOTILE

Une preuve de notre qualité

TAB 81 483 812

MATERIAL SAFETY DATA SHEET		
SECTION I - PRODUCT IDENTIFICATION		
Name : chrysotile asbestos	Chemical family : fibrous hydrated silicates	
Synonym : white asbestos	Formula : $3MgO \, . \, 2SiO_2 \, . \, 2H_2O$	M.W. : ca 283
Class 9 - UN no. 2590 - PG III -RQ	EPA Code Designation : A-152-4672	EEC Number : 650-013-00-6
WHIMS Classification: D2A		
SECTION II - HAZARDOUS INGREDIENTS		
Chrysotile Asbestos (95-98%)	TLV : 0.1-2.0 f/ml (see the countries regulations)	
CAS Registry Number : 12001-29-5		
SECTION III - PHYSICAL DATA		
Physical state : solid	Appearance : white fibrous dry material	Odor : odorless
Specific gravity : 2.4 - 2.6	Solubility in water : insoluble	pH ~ 10
Boiling point : not applicable	Melting point : dehydrates above 580°C	
Vapour pressure : not applicable	Evaporation rate : not applicable	Percent volatile : not applicable
SECTION IV - FIRE AND EXPLOSION HAZARD DATA		
Flammability : non-flammable	Explosion sensitivity : no explosion hazard	
Flash point : not applicable	Combustibility : non-combustible	
SECTION V - REACTIVITY DATA		
Stability : very table	Incompatibility (material to avoid) : none	
Hazardous decomposition or by products : Not Applicable		Hazardous polymerization : will not occur
SECTION VI - HEALTH HAZARD DATA		
Route of entry : inhalation		
Acute effects : no immediate reaction to overexposure to asbestos dust		
Chronic effects : a prolonged overexposure may provoke asbestosis and increase risk of lung cancer		
Toxic effects : listed as a carcinogen or potential carcinogen under NTP-OSHA-IARC		
Ingestion : not hazardous	Eye contact : inert dust may cause irritation	
Skin contact: inert dust. It is not absorbed. Remove asbestos slivers		

LAB Chrysotile
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TAB 81 483 812

SECTION VII - PREVENTIVE MEASURES	
Personal protection:	use respirators in accordance with Article 15 of the Convention 162 adopted by the International Labour Conference, Geneva, June 24, 1986.
Ventilation:	local exhaust system and/or high efficiency particulate aerosol (HEPA) dust collection to within Threshold Limit Value (TLV).
Other protective equipment:	when risks of excessive concentration, use special clothing and protective equipment in accordance with Articles 15 and 18 of the Convention 162 adopted by the International Labour Conference, Geneva, June 24, 1986.
Handling and storage:	maintain good housekeeping practices. Clean waste with HEPA vacuum cleaner and place in closed containers. Local ventilation, material wetting and/or respiratory protection is required for all sawing, grinding, cutting, bulk handling, spraying, demolition, removal or other activities where dust exposure may occur. Avoid inhalation of dust.
Spill and leak procedure:	clean with HEPA vacuum cleaner. Repair the leaks. If sweeping is necessary, wet-down spillage. Place all material in sealed impermeable containers. Use approved respiratory and protective equipment.
Waste disposal method:	disposal of waste in accordance with Article 19 of Convention 162 adopted by the International Labour Conference, Geneva, June 24, 1986.
Other precautions:	smoking increases the risk of serious bodily harm. See danger label and handling instructions on bag.
SECTION VIII - FIRST AID MEASURES	
Inhalation:	no acute toxicity. Avoid breathing excessive dust when handling, dumping and mixing.
Eyes:	dust may cause irritation: eye protection is recommended.
Skin:	inert dust. Clean with water.

SECTION IX - PREPARATION INFORMATION	
Date prepared : March 27, 2009	Previous edition: December 14, 2007
Phone number : (418) 338-7500	FAX : (418) 338-9521
Prepared by : Health & Safety Department	

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APPENDIX 3 - SAFE USE INSTRUCTION FOR PROCESSING CHRYSOTILE-CEMENT PRODUCTS

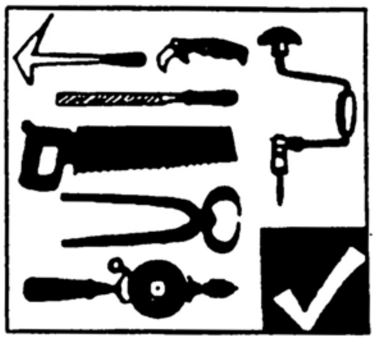
SAFE USE INSTRUCTIONS FOR PROCESSING CHRYSOTILE CEMENT PRODUCTS

Asbestos-cement products contain approximately 90% of hydrated cement and 10% of chrysotile asbestos fibres, which are firmly bound in the cement matrix.

Whenever possible, use products which are pre-finished (pre-cut and/or pre-perforated) in the factory.

If, nevertheless, products need to be machined on site, creation and inhalation of fine dust must be avoided, observing the following instructions:

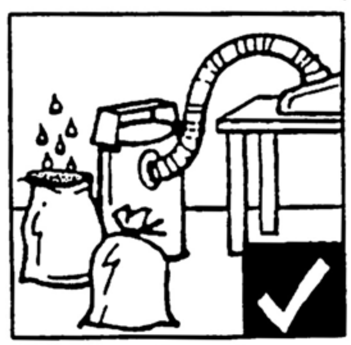
- **operate, if possible, outdoors or in a well ventilated place**
- **dampen the product before cutting or drilling**



Use handtools, which produce mainly coarse, non-respirable dust.

Never use high-speed tools, which create large quantities of respirable dust (e.g. high-speed abrasive tools such as angle grinders). (1)

Prior to collecting it, dust from processing products must be dampened. It must be collected in properly sealed containers and deposited in accordance with legal waste disposal provisions.



Stationary cutting equipment for large building sites must be fitted with vacuum dust extraction. The dust collected in plastic bags must be solidified by adding water prior to being deposited in accordance with legal provisions.

(1) Use only low-speed tools, equipped with HEPA aspirating system.

3

Regulations

3. Regulations

INTRODUCTION

The purpose of this section is to provide a brief overview of regulations on chrysotile asbestos as well as other natural and man-made fibres. Quebec, Canada will be used as the main example, with important comparisons made to the United States. An overview of international asbestos regulations is presented in APPENDIX 1.

3.1 ILO CONVENTION 162

Regulatory developments on asbestos fibres have been guided by ILO Convention 162 "*Safety in the Use of Asbestos*". This Convention was adopted in June 1986, by unanimous consent of government, industry and labour representatives from over 125 countries. To date, 32 countries have ratified Convention 162 and others are in this process of taking similar action.

3.1.1 Controlled Use

ILO Convention 162 provides for a hierarchy of preventive and control measures for asbestos. These include:

1. The prescription of adequate engineering controls and work practices;

2. The prescription of special rules and procedures for the use of chrysotile or certain types of asbestos or products containing asbestos or for certain work processes;

3. Where necessary to protect the health of workers and technically practicable, the replacement of asbestos or of certain types of asbestos by other materials or the use of alternative technology scientifically evaluated by the competent authorities as harmless or less harmful; and,

4. Total or partial prohibition of the use of asbestos or of certain types of asbestos in certain work processes.

Clearly the emphasis of ILO Convention 162 is on controlled-use and not product prohibitions. Indeed, the Convention only calls for 2 specific prohibitions: crocidolite and all products containing crocidolite, and sprayed-on applications of asbestos. National regulations in Canada, the U.S. and other countries tend to have longer lists. More information on this subject is presented later.

3.1.2 Framework for National Regulations

The general responsibilities of government, industry and labour and hence the recommended overall framework of national regulations governing safety in the use of asbestos are also found in ILO Convention 162.

National regulations should do the following:

- Establish procedures for the notification by the employer of those workplaces where chrysotile or materials containing asbestos will be handled;
- Prescribe appropriate engineering controls and work practices to prevent or control exposure to chrysotile fibres and other types of asbestos, including brochures for dealing with emergency situations;
- Enforce laws and regulations with an adequate system of inspection and appropriate penalties;
- Prescribe limits for the exposure of workers to chrysotile and measures to make employers comply with the reduction of exposure to as low a level as is reasonably practicable;
- Specify the methods and frequency of the measurements by the employer, of the concentrations of airborne asbestos dust in the workplace and ensure that inspectors, workers and their representatives have access to the monitoring records;
- Prescribe measures to ensure that pollution of the general environment by chrysotile released from the workplace is prevented;
- Require employers to establish programs for the education and training of workers on methods of prevention and control;
- Establish the standards for respiratory equipment and the use and handling of protective clothing provided to workers;
- Establish procedures for the recognition of contractors qualified to carry out the removal of friable asbestos from buildings or the demolition of structures containing asbestos;
- Ensure that workers, who are or have been exposed to asbestos, are provided with free medical examinations to monitor their health in relation to the hazard;
- Prescribe labelling and packaging requirements for chrysotile and asbestos-containing products in a language and manner easily understood by workers and users concerned, including material safety data sheets.

3.1.3 Consultation and Cooperation

- Both ILO Convention and the ILO Code of Practice on Safety in the Use of Asbestos encourage close cooperation and consultation between governments, industry and labour. Indeed, they are essential ingredients to realize controlled-use in practice.
- More specifically, multi-party committees comprised of government, industry, labour officials and members of the academic community should be established and charged with drafting standards and dealing with other important policy questions.

- At the industry level, trade associations should be established to facilitate the transfer of information and technology within the industry, and to develop a common position when inputting into the regulatory process.
- Finally, and most importantly, consultation and cooperation at the plant level is necessary. In this regard, joint safety and health committees should be set up to oversee the development and implementation of appropriate dust prevention programs.

3.1.4 World Health Organization, Oxford, U.K. 1989
Occupational Exposure Limit for Asbestos

Recommendations made by a Group of Experts, brought together by the WHO in 1989, concluded that no employee should be exposed to a concentration of airborne chrysotile asbestos greater than 1 fibre/ml.

3.2 CHRYSOTILE AND ASBESTOS REGULATIONS IN CANADA

In Canada, the regulation of hazardous materials is based on the life cycle approach. That is, all activities from mining, transportation, manufacturing, installation and repair, to removal and disposal are addressed in order to protect not only public and worker health, but also the general environment.

Moreover, development and implementation of regulations is done in a climate of close cooperation between all social partners. Labour, in particular, plays a major role, not only at the plant level by actively participating in joint health and safety committees, but also at the national level in terms of developing policy and regulations.

Canada was one of the first countries to ratify ILO Convention 162. The process of ratification, which was completed in 1988, sparked a great deal of activity in Canada as regulatory authorities, at both the federal and provincial levels, moved to bring existing regulations into compliance with ILO Convention 162.

In Canada, jurisdiction over matters related to environmental protection and occupational health and safety rests primarily with the provinces. The Province of Quebec provides a good example of the type of amendments to chrysotile and other types of asbestos regulations which have been taking place in Canada in recent years.

3.2.1 Exposure Limit Values/ Fibre Restrictions

In January 1990, Quebec moved to lower its permissible exposure limits for chrysotile asbestos to 1.0f/cc and 0.2f/cc for both crocidolite and amosite. At the same time, the Province introduced prohibitions on the use of friable insulation materials, as well as crocidolite and amosite, although derogations are permitted with respect to the latter substances. All work involving in-place crocidolite and amosite containing materials must respect a 0.2 f/cc standard.

3.2.2 Construction Activities

Quebec has also amended its construction code to ensure adequate worker protection for those workers handling chrysotile and other types of asbestos in non-fixed work-places. Integral to this regulation is a three-tier classification of work:

Type I jobs - or low risk activities pertain to all work with non-friable or high density products, where the use of hand tools or vacuum equipped power tools can reduce exposures to well below the exposure limit. Procedures must be taken to minimize exposures, prevent the spread of dust and dispose of chrysotile and other types of asbestos waste. Respiratory protection equipment is not mandatory, but should be provided to workers upon request.

Type II jobs - or medium risk activities involve minor disturbances or minor removal of friable materials containing chrysotile and other types of asbestos. More stringent prevention and control measures are required, compared to Type I jobs. Glove bag techniques are often used to remove pipe insulation. Workers are required to wear special protective clothing and a half-face negative air pressure HEPA filter respirator.

Type III jobs or high risk activities include large scale removal of friable chrysotile and other types of asbestos-containing materials, spray application of sealants to friable ACMs, etc., and require very stringent workplace practices. For inside jobs, the ventilation system must be turned off, the work area totally enclosed and maintained under negative pressure, a decontamination centre constructed, and appropriate personal protective equipment issued to workers.

3.2.3. Waste Disposal

Regulations have also been introduced in Canada to address the disposal of asbestos waste, particularly from demolition projects. More specifically, provision is made for safe transportation (e.g. covered vehicles, packaging, labelling of containers); disposal at approved landfills only; and, prompt burial under various levels of material. In general, these regulations apply to friable asbestos waste, not high density products.

Disposal of waste containing friable asbestos poses very different issues than disposal of most toxic materials. Unlike most toxic substances (e.g. lead, benzene, arsenic), which can migrate to water and pose a risk when ingested, asbestos poses a risk only when inhaled. As a result, no other requirements are necessary other than to cover friable asbestos waste under a layer of non-asbestos materials.

As in the United States, most high-density asbestos-containing waste products can be disposed of in any municipal or industrial landfills.

3.2.4 Product Restrictions

At the Federal level, the Hazardous Products Act prohibits the use of asbestos in the following products or applications: untreated, low-quality textile products which can release fibres under normal use; various consumer products, such as toys, modelling compounds, and low-density jointing compounds; the sale of loose or raw asbestos to consumers; all asbestos products destined for application by spraying; and finally, the use of crocidolite and crocidolite-containing products. A number of provinces in Canada have also banned the use of amosite and the use of asbestos-containing boiler and pipe insulating materials that can become friable.

3.2.5 Labelling Requirements

Regarding labelling, the Workplace Hazardous Materials Information System (WHMIS) was introduced in 1987, under the Federal Hazardous Products Act. It requires suppliers of all hazardous materials to provide labels with specific pictograms and warning phrases, along with Material Safety Data Sheets (MSDS) as a condition of sale and importation.

WHMIS also requires that workers receive appropriate information and training if called upon to work with or handle hazardous substances and products.

In the case of **chrysotile**, it is considered a Class D2 substance - a chronic toxic material, not an acute toxic substance. As a result, all bags of chrysotile and other types of asbestos fibre and all products containing asbestos must bear the Toxic T label and appropriate warning phrases (see **APPENDIX 2**).

3.2.6 Transportation

Under the Federal Transportation of Dangerous Goods Act, and consistent with the International Maritime Dangerous Goods Code, asbestos fibre is considered to be Class 9, Miscellaneous Products or Substances. As a result, chrysotile asbestos bags, pallet loads and/or containers must display the UN label **Asbestos - White No. 2590**. Also, asbestos fibres must be packaged in multiple sift-proof plastic bags. Strong sift-proof paper bags may be acceptable where a pallet load is stretch or shrink-wrapped. Unit loads must be transported in closed freight containers only. No special requirements are necessary for transporting high-density chrysotile products.

3.2.7 Medical Surveillance

In addition to an initial, pre-assignment medical evaluation, factory and mine workers are required to undergo yearly medical evaluations. All medical documents must be filed and kept for a minimum of 40 years after cessation of employment.

3.2.8 Monitoring

The measurement of airborne chrysotile fibre in the work-place must be undertaken at least once per year. Specific monitoring techniques, objectives and management practices are described in greater detail in Section 6.

3.2.9 Stack Emissions

Finally, under the Canadian Environmental Protection Act, regulations have been established governing stack emissions from asbestos mines and mills. An emission limit of 2.0 f/cc has been established, in addition to appropriate monitoring methods and administrative controls. No such standards apply to chrysotile and other types of asbestos-product manufacturing facilities.

3.2.10 Fines and Penalties

In Canada, emphasis is on promoting voluntary compliance with requirements. Inspection programs are in place, compliance is monitored, and non-compliance is followed-up, including prosecution through the courts, with imposition of maximum penalties in a number of cases. Fines and other penalties vary among federal and provincial jurisdictions.

3.3 COMPARISON TO THE UNITED STATES

Chrysotile and other types of asbestos regulatory instruments in the United States are similar in coverage and nature to those that exist in Canada, with some important differences.

3.3.1 Product Restrictions

As a result of the U.S. Court of Appeals' decision to overthrow the U.S. EPA's asbestos ban and phase-out rule in October

1991, restrictions on asbestos use do not differ greatly between Canada and the United States.

3.3.2 Fibre Restrictions

The United States of America provides for the continued use of crocidolite and amosite, whereas the use of these fibres and products containing these fibres, have been or will be, prohibited in most Canadian provinces.

3.3.3 Exposure Limits

The U.S. remains one of the few industrialized countries which do not differentiate between fibre types. An exposure limit of 0.1f/cc applies to all work involving all types of asbestos fibres in the United States. In the United States, an excursion limit of 1.0 f/cc, as averaged over a sampling period of 30 minutes, is also applied to short duration projects (OSHA).

3.3.4 Action Levels

Based on industrial hygiene approaches, the "action level" is set at half the threshold limit value (TLV). The "action level" if exceeded, triggers specific compliance activities, including worker training, medical surveillance and work-place monitoring requirements. The action level is more relevant for the non-fixed workplace where the transitory nature of the work force and intermittent worker exposures would make various employer responsibilities very difficult and costly to fulfill.

3.3.5 Stack Emissions

In the U.S., a no visible emissions standard applies to stack emissions. In Canada, a 2.0 f/cc stack emission limit has been established for chrysotile mines and mills only.

3.3.6 Labelling

In the United States and Canada bags of chrysotile fibre and chrysotile products are required to carry an appropriate risk phrase and hazard warning. No label is required in the USA for asbestos products that the manufacturer can demonstrate the PEL or excursion limit will not be exceeded.

3.4 FRIABLE ASBESTOS INSULATION IN BUILDINGS

There are no regulations in North America requiring the immediate removal of in-place friable insulation materials; however, building owners are required to put in place appropriate management programs. Moreover, any work which disturbs in-place friable insulation materials must be undertaken according to very strict workplace standards. This applies not only to removal operations, but also maintenance and custodial work.

In Ontario, Canada's most populous province, provincial regulations require building owners with friable asbestos-containing materials on their properties, to establish an operations and maintenance program. (O. Reg. 278/05, under the Occupational Health & Safety Act)

In the United States, the Asbestos Hazard Emergency Response ACT (AHERA) provides for similar requirements for all public and private schools.

Similar legislation was contemplated for public and commercial buildings, but not adopted. Following publication of the Health Effects Institute - Asbestos Report (HEI-AR), EPA concluded that building occupants are not at significant risk and that existing EPA and OSHA standards provide sufficient protection for custodial and maintenance workers who are potentially at risk. Building owners, however, are expected to follow guidelines as provided in EPA's Green Book.

Removal of friable ACMs is strictly regulated in both Canada and the United Sates. Prior to commencement of work, authorities must be notified and a plan of action submitted providing detailed work plans, including when, where and how the work will be conducted as well as where waste materials will be deposited.

In the USA, AHERA regulations specify that only licensed contractors and workers are permitted to undertake ACM removal. In addition, regular air monitoring by accredited consultants and laboratories is required, as is the use of negative air pressure in all major removal jobs. For small scale, short duration AHERA asbestos abatement projects a clearance level of 0.01f/cc as determined by phase contrast microscopy must be met. And, for large scale AHERA abatement projects, a clearance level of 70 structures per millimetre squared as determined by transmission electron microscopy must be met.

In Canada, regulations have been amended to provide for a clearance level of 0.01f/cc, the use of negative pressure on large-scale removal jobs, (class 3 jobs – see Section 7, 7.5) and very importantly, the use of certified workers, supervisors and contractors in removal work.

The stringent workplace practices required for work with friable insulation materials is testimony to the risks to workers when handling these very dusty friable products. They contrast with those recommended for work with non-friable products, which are relatively simple and straightforward as the fibre is locked-in or encapsulated in a cementitious or resinous matrix. It is, therefore, very important to differentiate between friable and non-friable products for regulatory purposes.

3.5 OTHER NATURAL AND MAN-MADE FIBRES

In most countries today, work involving exposure to airborne fibrous materials is covered by general regulations on occupational health and safety, and on man-made mineral and synthetic fibres. Indeed, at the time of the 1989 ILO survey, only Sweden had specific regulations, the Swedish Ordinance concerning synthetic and organic fibres, which was issued by the National Swedish Board of Occupational Safety and Health in March 1982. The only other country with formal regulations in the field today is Australia, which, in May 1990, adopted a National Standard and National Code of Practice for Synthetic Mineral Fibres. In the United Kingdom, Guidance Note EH46 prepared by the Health & Safety Executive, provides guidelines for work with man-made mineral fibres (MMMFs), but has advisory status only. However, exposure limit values are provided in the Control of Substances Hazardous to Health regulation and have the force of law. A summary of existing and proposed PELs for natural and man-made respirable fibres is presented in **APPENDIX 1, ANNEX III**.

3.5.1 Labelling

The fact that IARC (International Agency for Research on Cancer) has classified various man-made mineral fibres as "possibly carcinogenic to man" triggers labelling and hazard warning requirements for manufacturers, under WHMIS in Canada and OSHA's Hazards Communication Standard in the United States.

In Canada, a typical pictogram and hazard warning is demonstrated in the label for refractory ceramic fibre (see **APPENDIX 3**). Standards and guidelines for controlling worker exposures to RCFs vary in the United States. (see **APPENDIX 4**).

Although under review, MMMFs are at present not classified in any category of carcinogenicity under the EEC Commission Directive on Classification, Packaging and Labelling of Dangerous Substances. Therefore, there are no requirements on MMMF manufacturers to label their products. MSDS' and product safety information sheets, however, are provided on a voluntary basis (see **APPENDIX 5**).

3.5.2 Exposure Limits

In 1994, most countries in the world treated MMMF as nuisance dust and in most cases followed a standard of 5 mg/m^3 for respirable dust. However, a number of countries have moved to introduce more stringent fibre number and gravimetric standards for MMMF. In Denmark, stationary workplaces must meet a 2.0 f/ml fibre number standard, and in non-stationary workplaces a 5 mg/m^3 total dust standard is in effect. In Sweden, all work involving synthetic or inorganic fibres must meet a 1.0 f/ml standard and in the United Kingdom, a fibre number standard of 2.0 f/ml applies, as well as a total inhalable dust limit of 5 mg/m^3.

In the United States, OSHA has recently proposed a 1.0 f/cc standard for fibrous glass and refractory ceramic fibres and mineral wool. In Australia, all work with synthetic mineral fibres must meet a 0.5 f/ml standard as well as a 2 mg/m^3 inhalable dust standard.

In Canada, Alberta has moved to introduce fibre number exposure limit values for work with MMMFs. A limit of 1.0 f/cc has been adopted for fibrous glass and mineral wool, and a 0.5 f/cc limit for refractory ceramic fibres. A total dust standard of 5 mg/m^3 also applies for work with these materials in Alberta.

Quebec has introduced comprehensive exposure limit standards for natural and man-made fibres. More specifically, new regulations call for a 2.0 f/cc limit value for glass wool and a 1.0 f/cc limit value for rock and slag wool, special purpose glass fibre, refractory ceramic fibre, wollastonite, attapulgite and para-aramid fibres (see **APPENDIX 1, ANNEX III**).

3.5.3 Codes of Practice

In Canada, three separate initiatives are presently ongoing to develop a Code of Practice for work involving man-made mineral fibres - one by the Quebec Federation of Labour (QFL 1997), one by Canadian producers of fibrous glass and mineral wool, and one by a tripartite committee spearheaded by the Ontario government. The Code was developed by an experts' committee involving trade unions from Australia, the United States and various provinces from across Canada. It will be published in the near future following international peer review.

Integral to the QFL Code of Practice, is a three-tier system of work which recognizes the dustiness of different applications and activities, and the need for appropriate preventive measures at each level to minimize the risk to workers. The Code also distinguishes between RCF and other insulation wools, recognizing the greater hazards presented by these products. The duties of employers, recommended work practices, personal hygiene, medical surveillance, and labelling, monitoring and training requirements are also clearly outlined.

In sum, it is clear that appropriate preventive and control measures should be adopted with any material likely to release respirable fibres, similar to those developed for chrysotile asbestos.

APPENDIX 1 - AN OVERVIEW OF INTERNATIONAL REGULATIONS FOR ASBESTOS AND OTHER NATURAL AND MAN-MADE FIBRES

OVERVIEW

INTERNATIONAL REGULATIONS FOR CHRYSOTILE, ASBESTOS AND OTHER NATURAL AND MAN-MADE MINERAL FIBRES

Controlled Use Approach

A majority of countries in the world today subscribe to the controlled use approach to the regulation of asbestos, the principles of which are described in ILO Convention 162, *Safety in the use of asbestos.* Convention 162 was unanimously adopted by government, industry and union representatives from over 125 countries in June 1986. Since then, 32 countries have ratified the ILO Convention including Canada in 1988 (see **ANNEX I**).

Most regulatory regimes distinguish between different types of asbestos and asbestos products. Consistent with the recommendations of scientific meetings convened since the mid 1980's, by the World Health Organization (WHO), the trend has been towards a complete ban of the commercial forms of amphibole asbestos (crocidolite & amosite) and low-density, friable products.

Continued use of chrysotile in high density products (chrysotile-cement, brake linings, etc.) is permitted, provided permissible exposure limits of 1.0f/cc or below are respected during mining, milling, manufacturing, installation, repair and removal activities. Occupational exposure limit values for selected countries are presented in **ANNEX II**.

Restrictive measures in certain countries – but chrysotile continues to be used

A number of countries have introduced restrictive measures, including the European Union (**ANNEX III**) whose ban was effectively implemented in 2005, with certain derogations allowed. The regulatory instruments used are best described as *technology forcing*, which are an integral element of a broader industry policy at promoting and protecting the development of new substitute products for national and regional markets. In all those countries, an exemption procedure is provided for, and it is believed that many, if not all continue to use asbestos products to this day.

Risks of substitutes result in growing regulatory attention

The concern regarding the health risks of substitute fibres is very real. The European Commission (EC) has developed a Directive on other fibres, which is consistent with international trends of recommending that appropriate controls be introduced for all substances likely to release respirable and durable fibres. The 1993 report by the International Program on Chemical Safety (IPCS) concluded " ..all fibres that are respirable and durable must undergo testing for carcinogenicity. Exposures to these fibres should be controlled to the same degree as that required for asbestos, until data supporting a lesser degree of control become available." The German MAK commission responsible for developing an annual list of maximum concentrations for hazardous substances upgraded the risks of man-made minerals fibres (MMMF).

The International Agency for Research on Cancer (IARC) Monographs programme recently evaluated the carcinogenic risks for airborne man-made vitreous fibres (2009). These products including glass wool, rock (stone wool) and slag wool have been extensively used for decades and studies to establish whether fibres are released during manufacture, use or removal of these products present a risk of cancer when inhaled. The Monographs working group concluded that only the more biopersistent materials remain classified by IARC as possible human carcinogens (Group 2B). These include refractory Ceramic fibres, which are used industrially as insulation in high-temperature environments such as blast furnaces, and certain special-purpose glass wools not used as insulating materials. In contrast, the more commonly used vitreous fibre wools including insulation glass wool, rock (stone) wool and slag wool are now considered not classifiable as to carcinogenicity to humans (Group 3). Continuous glass filaments, which are used principally to reinforce plastics, are also considered not classifiable as to carcinogenicity to humans (source: http://www.rcf.net/iarc).

Asbestos Ban in the U.S. Rejected by the Court of Appeals

It is important here to repeat that the United States of America has not banned asbestos. On October 18, 1991, the Fifth Circuit U.S. Court of Appeals overturned the Environmental Protection Agency's (EPA's) 1989 ruling that would have banned nearly all uses of asbestos in the U.S. by 1996. In a comprehensive 57-page opinion written by Judge Jerry E. Smith, the Court concluded that the "EPA failed to muster substantial evidence to support its rule." (see **ANNEX IV**). Overall, the Court simply could not believe that the costs of banning asbestos were justified given the small projected benefits of a ban and other ways in which similar amounts of money could be spent more productively for other purposes. The record before the Court, for example, showed that many more lives could be saved by the same money by building hospitals or schools, or by hiring more doctors for the poor. **ANNEX V** lists those asbestos containing products allowed and banned in the U.S.A.

What the Court's decision says about the wisdom of banning asbestos elsewhere

The Court did not talk about what its decision might say about the wisdom of banning asbestos in other countries. Of course, many of the same considerations that influenced the Court have worldwide application. For example, other countries should consider the risks of asbestos substitutes just as they were considered in the United States. In addition, because asbestos risks are well-known, asbestos is regulated much more stringently than substitutes in the United States just as in other countries.

In short, all the considerations that led the Fifth Circuit to invalidate EPA's asbestos ban apply with much greater force were a ban to be considered in Africa, Latin America and Asia. If banning asbestos would do more harm than good in the United States, then a similar ban would make even less sense elsewhere because there are so many more opportunities in those countries to deploy societal resources in a manner that will provide much more health protection and save many more lives.

Since the early 1970's the United States has regulated asbestos without regard to fibre type distinction. Beginning in 2001, the US EPA started the process, as part of its Integrated Risk Information System, of reviewing the most recent state of science on asbestos and three workshops have been held over the past 3 years (2009). After much discussion, and even though the panel of some 30 scientists concluded that "The general view of the Committee was there is sufficient evidence to support the need for the Agency's effort in developing risk assessment method(s) to account for potential differences in risk on the basis of mineral type and size characteristics of asbestos.". But the Committee "generally agreed that the scientific basis in the (EPA's technical document in support of the proposed method is weak and inadequate. As a result it is not expected that EPA will pursue updating its 1986 risk assessment for asbestos in the foreseeable future.

ANNEX I – COUNTRIES THAT HAVE RATIFIED ILO CONVENTION 162ILO CONVENTION 162

Adopted : June 1986	**32 ratifications**
Germany	18.11.1993
Belgium	11.10.1996
Bolivia	11.6.1990
Bosnia-Herzegovina	2.6.1993
Brazil	18.5.1990
Cameroon	20.2.1989
Canada	16.6.1988
Chile	14.10.1994
Cyprus	7.8.1992
Colombia	25.1.2001
Rep. Korea	4.4.2007
Croatia	8.10.1991
Denmark	18.12.2006
Ecuador	11.4.1990
Spain	2.8.1990
Ex-Yugoslavia & Macedonia rep.	17.11.1991
Finland	20.6.1988
Guatemala	18.4.1989
Japan	11.8.2005
Luxemburg	8.4.2008
Montenegro	3.6.2006
Norway	4.2.1992
Uganda	27.3.1990
Netherlands	15.9.1999
Portugal	3.5.1999
Russian Federation	4.9.2000
Serbia	24.11.2000
Slovenia	29.5.1992
Sweden	2.9.1987
Switzerland	16.6.1992
Uruguay	6.9.1995
Zimbabwe	9.4.2003

ANNEX II – OCCUPATIONAL EXPOSURE LIMIT VALUES

INTERNATIONAL ASBESTOS REGULATIONS
(Update – 2009)

COUNTRY	Asbestos in the Workplace			Asbestos dust in air emissions
	Chrysotile	Crocidolite	Amosite	
	(f/cc)	(f/cc)	(f/cc)	
ARGENTINA	2.0	0.2	0.5	N.A.; U.R.
BULGARIA	1.0	0.1	0.1	
BRAZIL (1)	2.0	N.A.	N.A.	N.A. (mines P.E.L. 0.7f/cc)
CANADA- QUEBEC	1.0	0.2	0.2.	2.0 f/cc, mines & mills.
COLOMBIA	1.0	N.A.	N.A.	
U.A.E.	2.0	0.2	N.A.	Croc. 0.2 f/cc, chrys. 0.5 f/cc
ECUADOR	1.0	N.A.	N.A.	N.A
EUROPEAN UNION	0.1	0.1	0.1	0.1mg/m³; U.R.
HUNGARY	2.0	2.0	2.0	
INDIA	2.0	2.0	2.0	4 f/cc or 0.2mg/m³
INDONESIA	1.0	1.0	1.0	N.A.
KOREA	1.0	N.A.	N.A.	Jan. 1, 2007
MEXICO	1.0	0.2	0.5	N.A., U.R.
MOROCCO	0.6	0.3	N.A	N.A.
NEW ZEALAND	1.0	0.1	0.1	N.A.
NIGERIA	1.0	N.A.	N.A.	
PAKISTAN	2.0	N.A.	N.A.	
PORTUGAL	0.1	0.1	0.1	0.1mg/m³; E.U.
ROMANIA	2.0	2.0	2.0	
RUSSIA	0.6	N.A.	N.A.	
SENEGAL	0.5	N.A	N.A.	N.A.
SOUTH AFRICA	0.2	1.0	1.0	N.A.
SPAIN	0.1	0.1	0.1	0,1mg/m³
SRI LANKA	0.5mg/³	N.A	N.A	No visible emissions
SWAZILAND	2.0	N.A.	N.A.	0.05 f/cc
TAIWAN (R.O.C.)	1.0	N.A.	N.A.	
THAILAND	5.0	N.A.	N.A.	U.R.
TURKEY	2.0	0.2	0.5	0.1 mg/m³
UNITED STATES	0.1	0.1	0.1	No visible emissions
VIETNAM	1.0	N.A.	N.A.	
ZIMBABWE	1.0	N.A.	N.A.	

N/A. Non-Applicable

(1) Brazil: limit value for chrysotile is 0.1 f/ml, agreement reached between workers and companies. Brazilian Fed. Legislation indicates that the limit for occupational exposure is 2.0f/ml, but all companies in Brazil follow 0.1 f/ml.

U.R. Under Revision

EXPOSURE LIMIT STANDARD FOR NATURAL & MAN-MADE RESPIRABLE FIBRES OTHER THAN ASBESTOS

	Australia	New Zealand	Denmark	Québec	Sweden	U.K.	U.S.A.
TOTAL DUST (mg/m^3)		5.0 mg/m^3	5.0 mg/m^3	10.0mg/m^3		5 mg/m^3	
RESPIRABLE DUST (mg/m^3)	2.0mg/m^3			5mg/m^3		5mg/m^3	5mg/m^3
MAN-MADE MINERAL FIBRES (f/cm^3)							
- Mineral Wools (All Categories)	0.5f/cm^3	1.0f/cm^3	1.0f/cm^3		1.0f/cm^3	2.0f/cm^3	1.0f/cm^3
(Superfine)	0.5f/cm^3	1.0f/cm^3			1.0f/cm^3	1.0f/cm^3	1.0f/cm^3
- Glass Wool				2.0f/cm^3			1.0f/cm^3
- Rock Wool				1.0f/cm^3			1.0f/cm^3
- Slag Wool				1.0f/cm^3			
- Refractory Fibre - (ceramic or others)	0.5f/cm^3			0.5f/cm^3		1.0f/cm^3	0.2f/cc
- Natural Minerals Fibres							
- Erionite				Use prohibited			n/a
- Attapulgite				1.0f/cm^3			n/a
- Wollastonite				1.0f/cm^3			n/a
- Synthetic Organic Fibres							
- Para-aramid (Kevlar, Twaron)				1.0f/cm^3			n/a
- Carbon Graphite							
- Polyelefin							

For up-to-date data, please consult web sites of: ACGIH, ATSDR, NIOSH, OSHA

ANNEX IV – EPA UPDATE

ENVIRONMENTAL PROTECTION AGENCY (EPA)

The Decision by the U.S. Court of Appeals

On October 18, 1991, the Fifth Circuit U.S. Court of Appeals overturned the EPA's 1989 ruling that would have banned nearly all uses of asbestos in the U.S. by 1996. In a comprehensive 57-page opinion written by Judge Jerry E. Smith, the Court concluded that the "*EPA failed to muster substantial evidence to support its rule*."

The Court found the EPA's support for a ban under the Toxic Substances Control Act (TSCA) deficient in several major ways:

- EPA failed "*to explore in more than a cursory way, the less burdensome alternatives to a total ban*". More specifically, it virtually ignored the feasibility of a controlled-use approach.
- The Court chastised the EPA for not evaluating "*the harm that will result from the increased use of substitute products*."
- The EPA refused to consider the "cost side of the TSCA equation," to meet the statutory requirement to "*balance the costs of its regulations against their benefits*."

November 4, 1991 – EPA asks for clarifications

On November 4, the EPA moved for a clarification of the Court's ruling regarding Phase I products, such as flooring and roofing, felt pipeline wrap and vinyl/asbestos tile, which under the rule, were banned as of August 1990. The EPA noted that it was allowed "to ban products that no longer are being produced in or imported into the United States." In its clarification, the Court indicated that EPA could ban only "*products that were not being manufactured, imported or processed on July 12, 1989*." The Court went on to say that any products whose manufacture or import ended after July 12, 1989, could only be banned after full assessment of their risks and benefits.

The clarification did not disturb the order accompanying the initial decision which vacated the EPA rule in its entirety.

November 15, 1991, EPA asks for rehearing

On November 15, the EPA filed a motion for a rehearing by the three-judge panel. The Agency did not ask the Court to reinstate the ban rule; it did, however, request a revised opinion that would allow EPA more discretion on remand. It argued that the Court had established unreasonably strict criteria for Toxic Substances Control Act (TSCA) rules. In particular, the Agency objected to the Court's statement that EPA must, before banning a product, assess the risks of all asbestos substitutes and the costs and benefits of less burdensome rules.

On November 27, 1991, the Court of Appeals reaffirmed its reversal of the Agency's 1989 rule. In a one sentence order, the Court denied the EPA motion.

With the proceedings before the Fifth Circuit now completed, the EPA has two options: 1) ask the U.S. Supreme Court, by February 27, 1992, to review the decision; or 2) initiate a new rulemaking on asbestos products following the criteria established by the Fifth Circuit U.S. Court of Appeals.

February 27, 1992 – EPA does not seek review by the U.S. Supreme Court: reversal on the ban of asbestos is final

On October 18, 1991, the Fifth Circuit U.S. Court of Appeals struck down the U.S. Environmental Protection Agency's (EPA's) 1989 rule, which would have banned most commercial uses of asbestos in the U.S. by 1996. The Court found the EPA's proposed ban deficient in several major ways.

The deadline for filing a petition for review, February 27, passed with no such petition being filed.

Thus, the reversal on the ban of asbestos is final. The EOPA has no further legal recourse – the ban regulation no longer exists.

Given the strength of the Court's ruling against the EPA and the decision not to appeal to the Supreme Court, it is unlikely that any future legislation banning asbestos could be accepted. With the increasing concern over the potential health risks of asbestos substitutes, a comprehensive legislation governing the controlled-use of all durable respirable fibres seems the most logical direction for the future.

November 5, 1993 – A/C sheets added to list of asbestos products authorized for use in the U.S.

On November 5, 1993, the EPA published a notice in the Federal Register confirming that A/C sheet (corrugated and flat), A/C shingles, asbestos clothing, roofing felt, millboard, pipeline wrap and vinyl asbestos tile are not subject to the 1989 ban rule.

Though the Court's 1991 decision did overturn the EPA rule in its entirety it did say that EPA could ban asbestos products listed in the rule, provided they were not being manufactured, imported or processed in the United States when the rule was published in July, 1989.

The U.S. based Asbestos Information Association /North America (AIA/NA) presented evidence to the EPA demonstrating that while some asbestos products were not being manufactured in the U.S., they were, however, being imported and used. The EPA accepted these arguments and confirmed that the products in question are not subject to the 1989 ban rule.

ANNEX IV – EPA UPDATE

ENVIRONMENTAL PROTECTION AGENCY (EPA)

TRUE FACTS ABOUT THE U.S. COURT DECISION ON ASBESTOS

Years after the Court of Appeals ruling, much misinformation still continues to circulate regarding asbestos use in the United States. Mr. Ed. W. Warren, Lead Counsel for the North American asbestos industry challenge of the EPA Ban Rule and associate of the Washington-based law firm, Kirkland & Ellis, set the record straight.

Legally binding effect of the Court's decision
We have been told repeatedly that unidentified EPA, AID and/or U.S. Embassy officials may have stated or claimed that asbestos use remains unlawful in the U.S. and/or that the Fifth Court of Appeals decision overturning the EPA ban decision is the law only in those states (Texas, Mississippi, Louisiana) comprising the Fifth Circuit. Such statements, if made, are plainly wrong.

*EPA's asbestos rule, issued in July 1989, was required to be challenged under the U.S. Toxic Substances Control Act within 60 days in any one of the twelve United States Courts of Appeals. Lawsuits were actually filed in nearly half of the twelve Courts by many different industries and environmental groups. By law, EPA's rule could be reviewed by only one of these Courts, and the Fifth Circuit was chosen as the Court to conduct a consolidated, nationwide review. The Fifth Circuit's subsequent decision invalidating EPA's asbestos ban, therefore, applies throughout the entire United States.

*The asbestos ban is accordingly dead everywhere throughout the U.S. It could only have been reinstated if EPA had appealed (and obtained reversal) of the Fifth Circuit's decision from the United States Supreme Court. EPA's lawyers and their in-court representatives from the Environment and Natural Resources Division in the Justice Department considered appealing but decided not to do so, presumably because they expected the Supreme Court would agree with the Fifth Circuit. The Fifth Circuit's judgement overturning EPA's ban, therefore, remains the "law of the land" everywhere in the United States.

*EPA theoretically could start over again and begin anew the Agency process that previously took more than 10 years before the 1989 issuance of a final asbestos rule. There is no evidence whatsoever that EPA will do this. Although EPA officials may not like what the Court did or its reasoning (and are free in our democracy to say so), EPA's actions tell the real story – EPA will not again attempt to ban asbestos because it lacks the evidence necessary to overcome the Fifth Circuit's decision and the reasons it gave for allowing asbestos use to continue in the United States.

Banning asbestos will "do more harm than good"

The Fifth Circuit court of Appeals decision is very persuasive and explains why the U.S. EPA will never begin new proceedings to ban asbestos use. The best way to understand the Fifth Circuit's opinion is to focus on the statutory "unreasonable risk" test that translates for non-lawyers into something like the old medical maxims – "first do not harm," or never take actions that do "more harm than good." In each of the respects summarized below, the Court found that EPA's asbestos ban would, on balance, do more harm than good.

*EPA itself calculated that banning products like A/C pipes and A/C shingles would save only two or three lives over the next three decades and would cost at least $72 million and $151 million, respectively, for each life saved. The Court noted, by comparison, that more lives were lost every year in the U.S. from the ingestion of toothpicks and that the extremely high costs of banning asbestos in relation to the trivial benefits was unreasonably in comparison to other regulations and other measures for reducing health risks.

*EPA also conceded that the risks posed by asbestos substitutes, such as PVC and ductile iron pipe, were closely comparable to those posed by A/C pipe. For this reason, even the very few lives that might theoretically be saved by banning asbestos were greatly exaggerated. In fact, the Court concluded that the net saving, after deducting the lives that must be attributed to using asbestos substitutes, would more likely be zero.

*The Court used a similar analysis to overturn EPA's ban of asbestos brakes and other asbestos friction materials. EPA had neglected to consider both the cancer risk from non-asbestos fibres substituted for asbestos in brake manufacture and the additional auto traffic deaths that might result if more effective asbestos brakes were banned. In short, as with A/C products, the Court feared that banning asbestos brakes would do more harm than good.

*Overall, the Court simply could not believe that the costs of banning asbestos were justified given the small projected benefits of a ban and other ways in which similar amounts of money could be spent more productively for the other purposes. The record before the Court, for example, showed that many more lives could be saved for the same money by building hospitals or schools, or by hiring more doctors for the poor.

What the Court's decision says about the wisdom of banning asbestos elsewhere

The Court did not talk about what its decision might say about the wisdom of banning asbestos in other countries. Of course, many of the same considerations that influenced the Court have worldwide application. For example, other countries should consider the risks of asbestos substitutes just as they were considered in the United Sates. In addition, because asbestos risks are well-known, asbestos is regulated much more stringently than substitutes in the United States just as in other countries.

EPA emphasized in its final rule that there were different considerations applicable abroad that might lead other countries not to follow EPA's lead. The most significant differences all related to America's comparatively greater wealth and in which its prosperity affects the cost-benefit balancing conducted by the Court. All of the following considerations, as EOPA itself acknowledged, underscore why it makes even less sense for other countries to ban asbestos.

*The benefits of asbestos, particularly as used in A/C products, are vastly greater in most countries that in the United States (and Western Europe). A/C products provide potable water, sewage removal, and shelter that are taken for granted in the fully developed world. The analysis employed by the Fifth Circuit would weigh these benefits very heavily against banning asbestos. Simply put, the enormous health benefits that flow from retaining asbestos use in most countries vastly outweigh any theoretical benefits that might accompany an asbestos ban.

*The benefits of continued asbestos use are compounded when foreign exchange considerations are taken into account. The record before the Court, for example, contained evidence that A/C pipe could be produced at significantly less foreign exchange cost than PVC pipe. As a result, poorer countries could afford to deploy comparatively more A/C pipe and achieve correspondingly greater health benefits without diverting scarce foreign exchange from other purposes.

*The cost-benefit ratios relied only the Court also constitutes an important point of reference. The United States has been regulating toxic substances very stringently for many years, but the Court could find no precedent for spending as much as $70 million to save a single statistical life. In Africa, Latin America, Asia and almost everywhere else, these cost-benefit ratios are wildly out of line. More stringent workplace regulations in these countries save lives at a cost many hundred or thousands of times lower. More telling still, public health programs, better nutrition and similar government initiatives undoubtedly prevent death and disease at a fraction of the costs of even workplace controls.

*In short, all the considerations that led the Fifth Circuit to invalidate EPA's asbestos ban apply with much greater force were a ban to be considered in Africa, Latin America, Asia and most of Europe. If banning asbestos would do more harm than good in the Untied States, then a similar ban would make even less sense elsewhere because there are certain many more opportunities in those countries to deploy societal resources in a manner that will provide much more health protection and save many more lives.

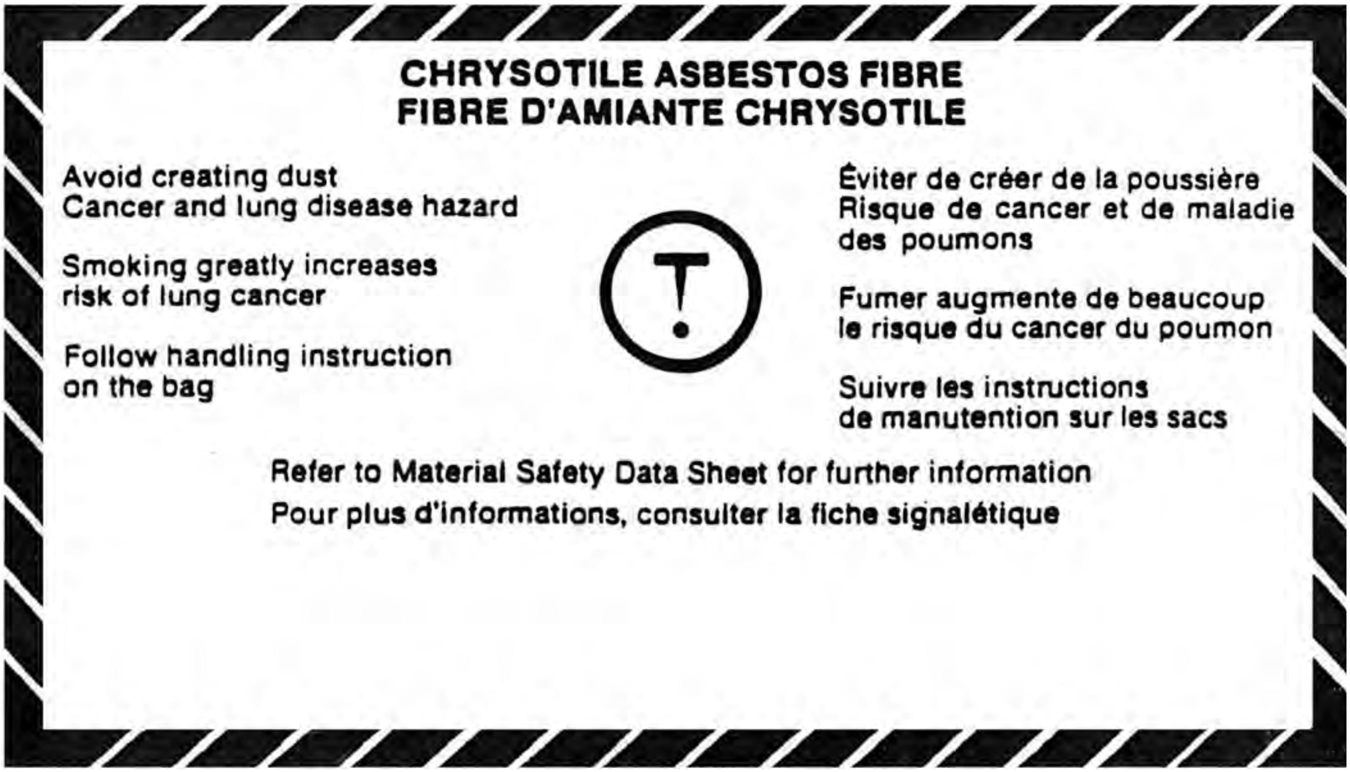
Edward W. Warren

ANNEX V – STATUS OF ASBESTOS PRODUCTS IN THE USA

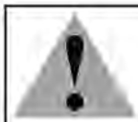
(AUGUST 2009)

Banned	Authorized
Corrugated paper	Corrugated asbestos cement sheet
Commercial paper	Flat asbestos cement sheet
Flooring felt	Vinyl asbestos floor tile
Rollboard	Asbestos cement pipes
Specialty paper	Asbestos cement shingles
New uses of asbestos	Friction materials
	Brake linings
	Clutch facing
	Disc brake pads
	Asbestos clothing
	Automatic transmission component
	Roofing felt
	Roof coatings
	Non-roof coatings
	Millboard
	Pipeline wrap
	Acetylene cylinder filler
	Asbestos diaphragms
	High-grade electrical paper
	Packings
	Sealant tape
	Brake blocks
	Missile liners
	Arc chutes
	Battery separators
	Reinforced plastic
	Textile products
	Gaskets

APPENDIX 2 - TOXIC "T" LABEL – CHRYSOTILE CONTAINING PRODUCTS



APPENDIX 3 - PRODUCT SAFETY INFORMATION LABEL - RCFs

	**EN** ATTENTION - This product contains Refractory Ceramic Fibres (RCF) - Based on animal tests, RCF may cause cancer by inhalation - Mechanical irritant to skin - Minimise dust - See ECFIA code of practice and Material Safety Data Sheet before use - RCF has been classified as a category 2 carcinogen under european Directive 67/548 - Restricted to professional users	**ES** ATTENCIÓN - Este producto contiene fibras cerámicas refractarias - Según estudios realizados en animales, puede causar cáncer por inhalación - En caso de fricción, pueden producirse irritaciones en la piel - Minimizar el polvo - Consúltese el código de práctica ECFIA y la ficha de datos de seguridad antes de su utilización - Las FCR han sido clasificadas como cancerígenas de 2 categoría según la Directiva europea 67/548 - Restringido a usos profesionales
	PT ATENÇÃO - Este produto contem fibras cerâmicas refractárias (FCR) - As experiências com animais indicam que as FCR podem causar cancro por inalação - O contacto com a pele pode causar irritação - Minimize a poeira - Consulte as instruções ECFIA e a ficha de dados de segurança antes da utilização - As fibras cerâmicas refractárias foram classificadas na categoria cancerígena 2 nos termos da directiva europeia 67/548 - Reservado aos utilizadores profissionais	**DA** ADVARSEL - Dette produkt indeholder keramiske fibre - Dyreforsøg har vist, at keramiske fibre kan forårsage kræft ved indånding - Lokalt hudirriterende - Minimer støv - Se ECFIAs adfærdskodeks og datablad om materialesikkerhed - Keramiske fibre er klassificeret som kræftfremkaldende stof i kategori 2 under EF-direktiv 67/548 - Udelukkende til erhvervsmæssig brug
DE ACHTUNG - Dieses Produkt enthält Keramische Mineralfasern - Tierversuche haben ergeben, dass bei Einatmung eine krebserzeugende Wirkung nicht ausgeschlossen werden kann - Hautreizungen sind möglich - Staubentwicklung vermeiden - Vor dem Gebrauch ECFIA-Handlungsanleitung und EG-Sicherheitsdatenblatt beachten - Keramikfasern wurden durch die EU Richtlinie 67/548 als Krebserzeugender Stoff Kategorie 2 eingestuft - Nur für den berufsmäßigen Verwender	**EL** ΠΡΟΣΟΧΗ - Το προϊόν αυτό περιέχει πυρίμαχες κεραμικές ίνες - Με βάση πειράματα σε ζώα οι πυρίμαχες κεραμικές ίνες μπορούν να προκαλέσουν καρκίν όταν εισπνέοντε - Σε περίπτωση τριβής μπορεί να προκληθεί ερεθισμός του δέρματος - Περιορίστε τη δημιουργία σκόνης - Συμβουλευτείτε το Εγχειρίδιο Χρήσης της ECFIA και το σχετικό δελτίο δεδομένων ασφαλείας πριν από την χρήση - Με βάση τις διατάξεις της Κοινοτικής Οδηγίας 67/548/ΕΟΚ, όπως ισχύουν, οι πυρίμαχες κεραμικές ίνες έχουν ταξινομηθεί ω καρκινογόνες ουσίες της κατηγορίας - Μόνο για επαγγελματική χρήση	**FI** HUOMIO - Tämä tuote sisältää tulenkestäviä keraamiset kuidut - Eläinkokeiden perusteella aine saattaa aiheuttaa syöpää sisään hengitettäessä - Aineen hankaaminen iholle aiheuttaa ärsytystä - Ilmassa olevan pölyn määrä on minimoitava - Tutustu ECFIA:N käyttöohjeisiin sekä materiaaliturvallisuustietoihin ennen käyttöä - Tulenkestävä keraaminen kuitu luokitellaan EU-direktiivin 67/548 mukaan 2.Luokan karsinogeeniksi - Vain ammattikäyttöön
IT ATTENZIONE - Questo prodotto contiene Fibra Ceramica Refrattaria (FCR) - Da esperimenti su animali risulta che le FCR possono provocare il cancro per inalazione - Possibile irritazione della pelle in caso di sfregamento - Minimizzare la polvere - Consultare il codice di comportamento pratico ECFIA e le schede di sicurezza prima dell'utilizzo - Le FCR sono state classificate nella categoria cancerogena 2 secondo la Direttiva Europea 67/548 - Unicamente ad uso di utilizzatori professionali	**NL** WAARSCHUWING - Dit product bevat vuurvaste keramische minerale vezels - Uit dierproeven is gebleken dat het inademen ervan kanker kan veroorzaken - Kan irritatie van de huid veroorzaken door wrijving - Stofontwikkeling zo gering mogelijk houden - Voor gebruik ECFIA-handleiding en blad met veiligheidsgegevens zorgvuldig doorlezen - Vuurvaste keramische vezels worden door de richtlijn van de Europese Commissie 67/548 als kankerverwekkende stof volgens categorie 2 geclassiceerd - Uitsluitend bestemd voor gebruik door professionele gebruikers	**SV** OBSERVERA - Produkten innehåller eldfasta keramiska fibrer - Ämnet kan ge cancer vid inandning (uppgiften baseras på djurförsök) - Hudirritation vid kontakt - Luftburet damm bör minimeras - Studera användningsinstruktionerna ECFIA samt informationsblad angående säkerhet före användning - Eldfast keramisk fibrer klassas enligt EU-direktiv 67/548 som ett karcinogent ämne av kategori 2 - Endast för yrkesmässigt bruk
FR ATTENTION - Ce produit contient des Fibres Céramiques Réfractaires (FCR) - Sur la base d'expérimentations animales, les FCR peuvent provoquer le cancer par inhalation - Irritation possible de la peau par frottement - Minimiser la poussière - Consulter le guide d'utilisation ECFIA ainsi que la fiche de données de sécurité avant utilisation - Les FCR ont été classées cancérogènes de catégorie 2 d'après la Directive européenne 67/548 - Réservé aux utilisateurs professionnels	**PL** UWAGA - Produkt zawierający substancje toksyczne (mineralne włókna ceramiczne) - Doświadczenia na zwierzętach wykazały, że może być przyczyną raka w następstwie narażenia drogą oddechową - Działa drażniąco na skórę w wyniku kontaktu mechanicznego - Należy unikać rozprzestrzeniania pyłów - Przed Użyciem należy zapoznać się ze specyfikacją ECFIA oraz z instrukcją dotyczącą bezpiecznego używania produktu - Włókna ceramiczne zostały zakwalifikowane w Dyrektywie Europejskiej 67/548 jako materiał kancerogenny drugiej kategorii - Zastrzeżone do profesjonalnego użytku	**HO** FIGYELEM - A termék kerámiaszálas anyagot tartalmaz - Állatkísérletek eredményeként az FCR belégzése rákot okozhat - Bőrirritáció lehetséges érintkezés esetén - Porképződést a lehető legkisebbre csökkentse - Felhasználás előtt tanulmányozza az ECFIA kódex leírását és a Biztonsági Adatlapot - Az Európai Irányelv (67/548) szerint 2-es kategóriájú rákkeltő anyagnak minősül - Kizárólag foglalkozásszerű felhasználása engedélyezett

 T R49, R38, S53, S45	**EN** REFRACTORY CERAMIC FIBRES TOXIC - May cause cancer by inhalation - Irritating to skin - Avoid exposure - obtain special instructions before use - In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible) - Restricted to professional users	**ES** FIBRAS CERÁMICAS REFRACTARIAS TÓXICO - Puede causar cáncer por inhalación - Irrita la piel - Evítese la exposición – recábense instrucciones especiales antes del uso - En caso de accidente o malestar, acúdase immediatamente al médico (si es posible, muéstresele la etiqueta) - Restringido a usos profesionales
	PT FIBRAS CERÂMICAS REFRACTÁRIAS TOXICO - Pode causar o cancro por inalação - Irritante para a pele - Evitar a exposição – obter instruções especificas antes da utilização - Em caso de acidente ou de indisposição, consultar imediatamente o médico (se possivel mostrar-lhe o rótulo) - Reservado aos utilizadores profissionais	**DA** KERAMISKE FIBRE GIFTIG - Kan fremkalde kræft ved indånding - Irriterer huden - Undgå enhver kontakt – indhent særlige anvisninger før brug - Ved ulykkestilfælde eller ved ildebefindende er omgående lægebehandling nødvendig; vis etiketten, hvis det er om muligt - Udelukkende til erhvervsmæssig brug
DE KERAMISCHE MINERALFASERN GIFTIG - Kann Krebs erzeugen beim Einatmen - Reizt die Haut - Exposition vermeiden - vor Gebrauch besondere Anweisungen einholen - Bei Unfall oder Unwohlsein sofort Arzt hinzuziehen (wenn möglich, dieses Etikett vorzeigen) - Nur für den berufsmäßigen Verwender	**EL** Πυρίμαχες κεραμικές ίνες ΤΟΞΙΚΟ - Μπορεί να προκαλέσει καρκίνο όταν εισπνέετι - Ερεθίζει το δέρμα εισπνοή - Αποφεύγετε την εισπνοή – εφοδιαστείτε με ειδικές οδηγίες πριν από την χρήσ - Σε περίπτωση ατυχήματος ή αν αισθανθείτε αδιαθεσία ζητήστε αμέσως ιατρική συμβουλή (δείξτε την ετικέττα α είναι δυνατό - Μόνο για επαγγελματική χρήση	**FI** KERAAMISET KUIDUT MYRKYLLISTÄ - Saattaa aiheuttaa syöpää sisään hengitettäessä - Ärsyttää ihoa - Vältä altistumista - tutustu erikoisohjeisiin ennen käyttöä - Onnettomuuden sattuessa tai pahoinvointitapauksissa käänny välittömästi lääkärin puoleen (näytä etiketti, jos mahdollista) - Vain ammattikäyttöön
IT FIBRE CERAMICHE REFRATTARIE TOSSICO R49 - Può provocare il cancro per inalazione R38 - Irritante per la pelle S53 - Evitare l'esposizione – procurarsi speciali istruzioni prima dell'uso S45 - In caso di incidente o di malessere consultare immediatamente il medico (se possibile, mostrargli l'etichetta) - Unicamente ad uso di utilizzatori professionali	**NL** KERAMISCHE MINERALE VEZELS VERGIF - Kan kanker veroorzaken bij inademing - Irriterend voor de huid - Blootstelling vermijden - vóór gebruik speciale aanwijzingen raadplegen - Bij een ongeval of indien men zich onwel voelt, onmiddellijk een arts raadplegen (indien mogelijk hem dit etiket tonen) - Uitsluitend bestemd voor gebruik door professionele gebruikers	**SV** KERAMISKA FIBRER GIFTIG - Kan ge cancer vid inandning - Irriterar huden - Undvik exponering - begär specialinstruktioner före användning - Vid olycksfall, illamående eller annan påverkan, kontakta omedelbart läkare, visa om möjligt etiketten - Endast för yrkesmässigt bruk
FR FIBRES CERAMIQUES REFRACTAIRES TOXIQUE - Peut causer le cancer par inhalation - Irritant pour la peau - Eviter l'exposition - se procurer des instructions spéciales avant l'utilisation - En cas d'accident ou de malaise, consulter immédiatement un médecin (si possible, lui montrer l'étiquette) - Réservé aux utilisateurs professionnels	**PL** MINERALNE WŁÓKNA CERAMICZNE SUBSTANCJA TOKSYCZNA - Może być przyczyną raka w następstwie narażenia drogą oddechową - Działa drażniąco na skórę - Unikać narażenia - przed stosowaniem zapoznać się z instrukcją - W przypadku awarii lub jeśli poczujesz się niezdrowo skonsultuj się z lekarzem (jeśli możliwe pokaż etykietę) - Zastrzeżone do profesjonalnego użytku	**HO** TŰZÁLLÓ KERÁMIA ROSTOK MÉRGEZŐ - Belélegezve rákot okozhat (karcinogén hatású lehet) - Bőrizgató hatású - Kerülni kell az expozíciót - használatához külön utasítás szükséges - Baleset vagy rosszullét esetén orvost kell hívni. Ha lehetséges, a címkét meg kell mutatni - Kizárólag foglalkozásszerű felhasználása engedélyezett

APPENDIX 4 - CODE OF PRACTICE - WORKING WITH CERAMIC FIBRE

7 Existing Standards and Recommendations

Standards and guidelines for controlling worker exposures to RCFs vary in the United States. Other governments and international agencies have also developed recommendations and occupational exposure limits that apply to RCFs. Table 7–1 presents a summary of occupational exposure limit standards and guidelines for RCFs.

Within the United States, the RCFC formally established a recommended exposure guideline of 0.5 f/cm³ as an element of its product stewardship program known as PSP 2002, which was endorsed by OSHA as a 5-year voluntary program [OSHA 2002]. As part of that program, the RCFC recommends that workers wear respirators whenever the workplace fiber concentration is unknown or when airborne concentrations exceed 0.5 f/cm³. This exposure guideline was established by the RCFC on October 31, 1997, and replaces the previous exposure guideline of 1 f/cm³ set by the RCFC in 1991.

Before this agreement, the OSHA General Industry Standard was most applicable to RCFs, requiring that a worker's exposure to airborne dust containing <1% quartz and no asbestos be limited to an 8-hr PEL of 5 mg/m³ for respirable dust and 15 mg/m³ for total dust [29 CFR 1910.1000].

NIOSH has not previously commented on occupational exposure to RCFs. However, in addressing health hazards for another SVF (fibrous glass), NIOSH [1977] recommended an exposure limit (REL) of 3 f/cm³ as a TWA for glass fibers with diameters ≤3.5 µm and lengths ≥10 µm for up to 10 hr/day during a 40-hr workweek. NIOSH also recommended that airborne concentrations determined as total fibrous glass be limited to a 5 mg/m³ of air as a TWA. At that time, NIOSH concluded that exposure to glass fibers caused eye, skin, and respiratory irritation. NIOSH also stated that until more information became available, this recommendation should be applied to other SVFs.

The Agency for Toxic Substances and Disease Registry (ATSDR) calculated an inhalation minimal risk concentration of 0.03 f/cm³ for humans based on extrapolation from animal studies [ATSDR 2002]. The Agency used macrophage aggregation, the most sensitive indicator of inflammation from RCFs, as the basis for this value. Calculation of this value is based on exposure assumptions for general public health that differ from those used in models for determining occupational exposure limits.

ACGIH proposed a TLV of 0.1 f/cm³ as an 8-hr TWA for RCFs under its notice of intended changes to the 1998 TLVs [ACGIH 1998]. On further review, this concentration was revised to 0.2 f/cm³ [ACGIH 2000]. ACGIH also classifies RCFs as a suspected human carcinogen (A2 designations) [ACGIH 2005]. On the basis of a weight-of-evidence carcinogenic risk assessment, the EPA [1993] classified RCFs as a Group B2 carcinogen (probable human carcinogen based on sufficient animal data).

ACGIH and EPA designations are consistent with that of the International Agency for Research on Cancer (IARC), which classified

Table 7–1. Occupational exposure limits and guidelines pertaining to RCFs[*], by country

Country	Regulated substance	Exposure limit[†]
Australia	Synthetic mineral fibers	0.5 f/cm^3
	Inspirable dust	2 mg/m^3
Austria	Total dust (lists superfine fibers as suspected carcinogen)	10 mg/m^3
Canada	RCFs	0.5 f/cm^3
Denmark	Manmade mineral fibers	1 f/cm^3
	Total dust (nonstationary work site)	5 mg/m^3
Finland	Glass wool and mineral wool	10 mg/m^3
France	General dust, mineral wool	10 mg/m^3
Germany	Synthetic vitreous fibers	0.5 f/cm^3
Netherlands	RCFs	1 f/cm^3
New Zealand	Synthetic mineral fibers	1 f/cm^3
Norway	Synthetic mineral fibers	1 f/cm^3
Poland	Glass wool	2 f/cm^3
	Total dust	4 mg/m^3
Sweden	Synthetic inorganic fibers	1 f/cm^3
United Kingdom [HSE 2004]	Machine-made mineral fibers (except RCFs and special-purpose fibers)	2 f/cm^3
	RCFs	1 f/cm^3
	Total dust (gravimetric limit)	5 mg/m^3
United States:		
ACGIH	RCFs	0.2 f/cm^3
ATSDR [2002][‡]	RCFs	0.03 f/cm^3
NIOSH[§]	RCFs	0.5 f/cm^3
	Glass fibers, other SVFs [NIOSH 1977]	3 f/cm^3
	Total fibrous glass	5 mg/m^3
OSHA [2002]	RCFs	0.5 f/cm^3
	Respirable dust (<1% quartz, no asbestos)	5 mg/m^3
	Total dust (<1% quartz, no asbestos)	15 mg/m^3

Source: Adapted and updated from U.S. Navy [DOD 1997].

[*]Abbreviations: ACGIH=American Conference of Governmental Industrial Hygienists; ATSDR=Agency for Toxic Substances Disease Registry; NIOSH=National Institute for Occupational Safety and Health; OSHA=Occupational Safety and Health Administration; RCFs=refractory ceramic fibers; REL=recommended exposure limit; TWA=time-weighted average.

[†]8-hr TWA unless otherwise specified.

[‡]Inhalation minimal risk level based on general public health assumptions, not occupational exposure.

[§]The NIOSH REL is established as a TWA for up to a 10-hr work shift in a 40-hr workweek.

ceramic fibers, including RCF, as "possibly carcinogenic to humans (Group 2B)" [IARC 1988, 2002]. The IARC characterization was based on "sufficient evidence for the carcinogenicity of ceramic fibers in experimental animals" and a lack of data on the carcinogenicity of ceramic fibers to humans [IARC 1988, 2002]. DECOS [1995] determined that "RCFs may pose a carcinogenic risk for humans," and set a health-based recommended occupational exposure limit of 1 f/cm^3.

The German Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area published a review of fibrous dusts [Pott 1997] classifying RCFs as category IIIA2, citing "positive results (for carcinogenicity) from inhalation studies (often supported by the results of other studies with intraperitoneal, intrapleural, or intratracheal administration)."

In the United Kingdom, the Health and Safety Commission of the Health and Safety Executive has established a maximum exposure limit for RCFs of 1.0 f/ml of air, with the additional advisory to reduce exposures to the lowest as reasonably practicable concentration based on the category 2 carcinogen classification for RCFs [HSE 2004].

4

Dust Control Measures: A General Overview

4. Dust Control Measures: A General Overview

INTRODUCTION

The general principles of dust control apply to the manufacture of chrysotile cement pipes and sheets, friction products (such as car brake linings), sealants, gaskets, coatings, textiles and to the installation and repair of these products. The methods of dust control described in this chapter are simple, effective and are readily available or can be made locally.

The reason it is necessary to control chrysotile as any mineral dust is because long term exposure to high concentrations can cause occupational diseases amongst workers. The inhalable dust of concern is not visible to the human eye. There are many locations in factories where any type of dust could be generated and released into the air. Controls are needed to prevent this from happening. This chapter is intended to provide guidance as to when controls are needed and what controls are available. Work practices and ventilation installations are described, along with methods for using them efficiently. Information concerning low level airborne concentrations which can result from an effective dust control program is also provided

Good control measures should include:

- Control at the source;
- Engineering controls;
- Work practices;
- Housekeeping;
- Personal protective equipment.

For additional information, consult the "Basics of Chrysotile Asbetos Dust Control", updated and published by the Chrysotile Institute, Fourth Ed. 2008.

4.1 CONTROL AT THE SOURCE

Control of dust should be achieved as near the source as possible. This increases the efficiency of the control process, minimizes costs and prevents the spread of dust into adjacent areas. The process of control must prevent emissions to the environment in order that a localized hazard in the factory is not converted into an environmental hazard. Therefore, if enclosure of the source is possible, this would be the first step to be taken.

4.2 ENGINEERING CONTROLS

Good engineering controls should include the following equipment:

- Dust hoods;
- Ductwork;
- Dust collector and fan;
- Make up air.

Proper engineering of each one of these components is essential. Among the different operations where industrial ventilation will be used are debagging, mixing, weighing, cutting, grinding, etc.

The elements of a complete local ventilation system are illustrated in **Figure 1**. A source of make up air or air to replace that exhausted through the hood must always be provided. The hood encloses the operation to the extent possible and provides a face velocity of air into the hood. As an example, for manual debagging, bags must be cut, emptied and disposed of inside a hood fitted with an exhaust connection. Cutting bags in half and handling empty bags outside the hood should be avoided. **Figure 2** shows one type of bag opening station.

Enclosure is practical when the operator does not need to have contact with the operation. In chrysotile cement plants a number of machine operations, such as the interior machining of couplings, can be enclosed. Enclosure is more common for the processing of smaller pieces but it is also used on larger equipment like belt conveyors, carding machines as shown on **Figures 3 and 4**.

It is important that all parts of the enclosure should be at a lower pressure than the associated worker's area. This may be achieved with a small amount of suction air. This air, after passing through the entrance to the hood, is exhausted through a series of proper size ducts to an air cleaner which is usually an industrial cloth filter or "bag house". The ducting may be joined with any number of other hoods and cleaning systems and may have pre-cleaning cyclones or settling chambers along the ducting. Good practice requires that the ducting have no blast gates or dampers, that the velocity be sufficiently high everywhere that the dust not fall out and plug the ducting and that the corners and bends of the ducting be designed so as to minimize wear and erosion.

The bag house must be sized to handle the quantity of air flow being exhausted through the hoods. The clean air passes through the suction fan and is exhausted to the outside. A dust monitor can be placed at this point to continuously check environmental conditions. However, this dust monitor is not considered an accurate measurement of chrysotile dust but rather of the relative changes in total dust concentrations over time. (Permissible concentration of respirable dust in re-circulated air is 0.1 mg/m^3). In modern practice the bag filter is the universally approved method of removing chrysotile dust from air. Cotton is the most efficient filter fabric for chrysotile dust collection (in humid condition, polyester bag is recommended).

The environment can be well controlled at all work places provided good preventive maintenance on all dust control equipment is performed and that inspections are made on a regular basis.

FIGURE 1 SCHEMATIC DIAGRAM OF A BASIC LOCAL VENTILATION SYSTEM

Dust Control Measures: A General Overview

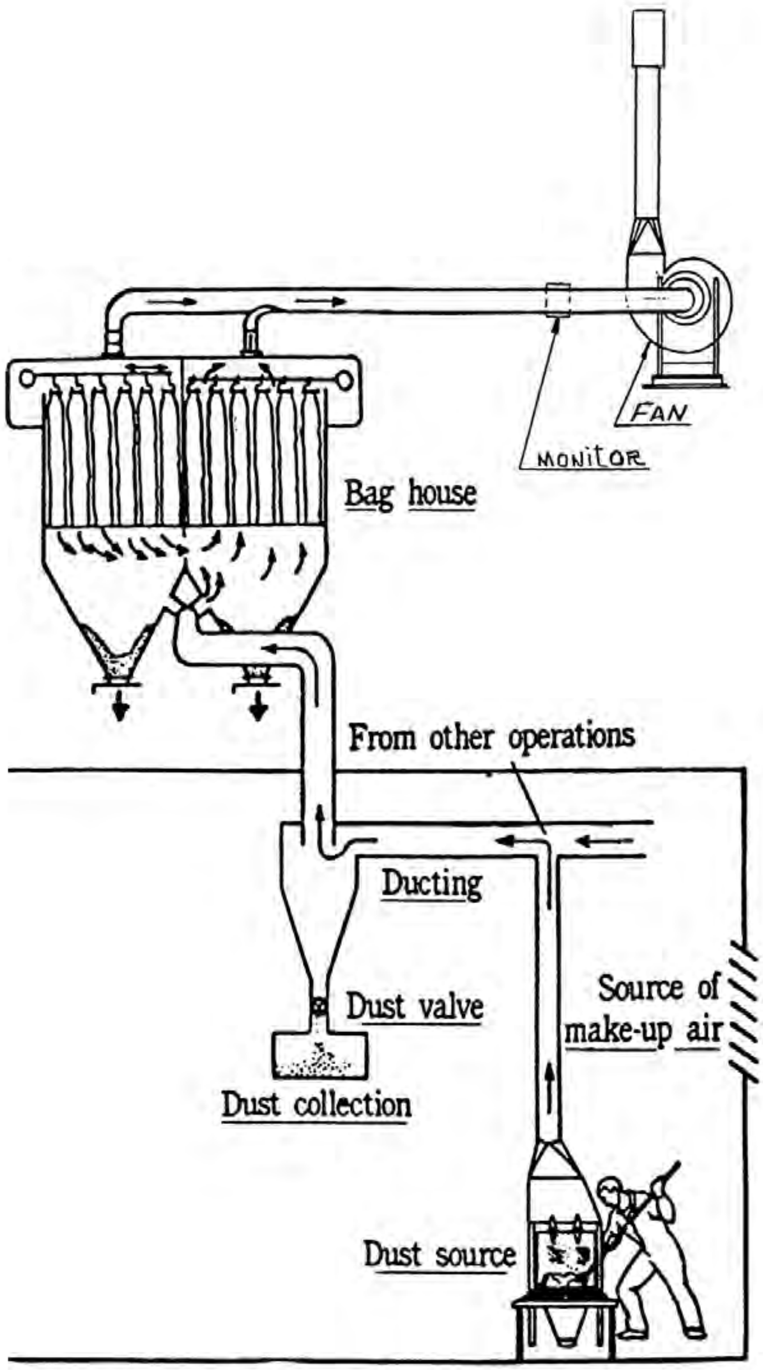


FIGURE 2 A BAG OPENING STATION

Dust Control Measures: A General Overview

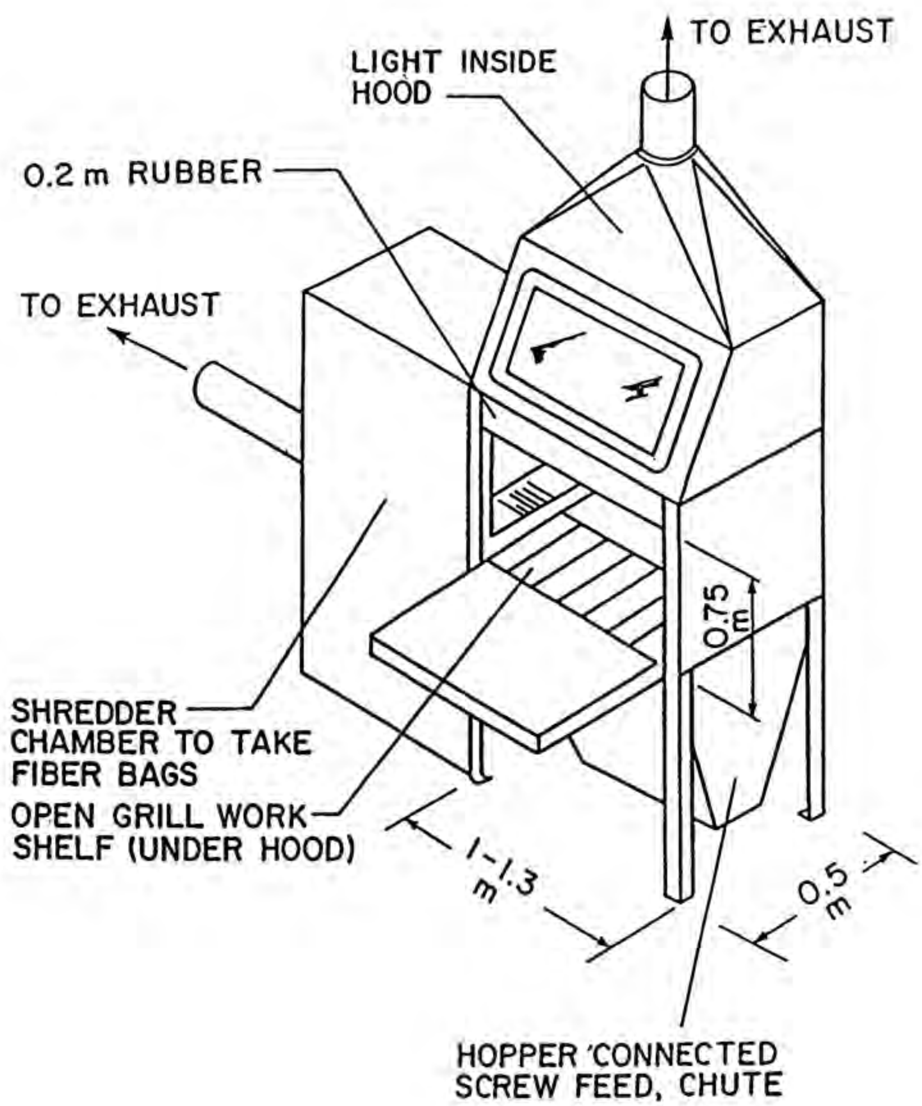


FIGURE 3 CONVEYOR ENCLOSURE FOR CONVEYOR BELT DUMPING OR TRANSFER

Dust Control Measures: A General Overview

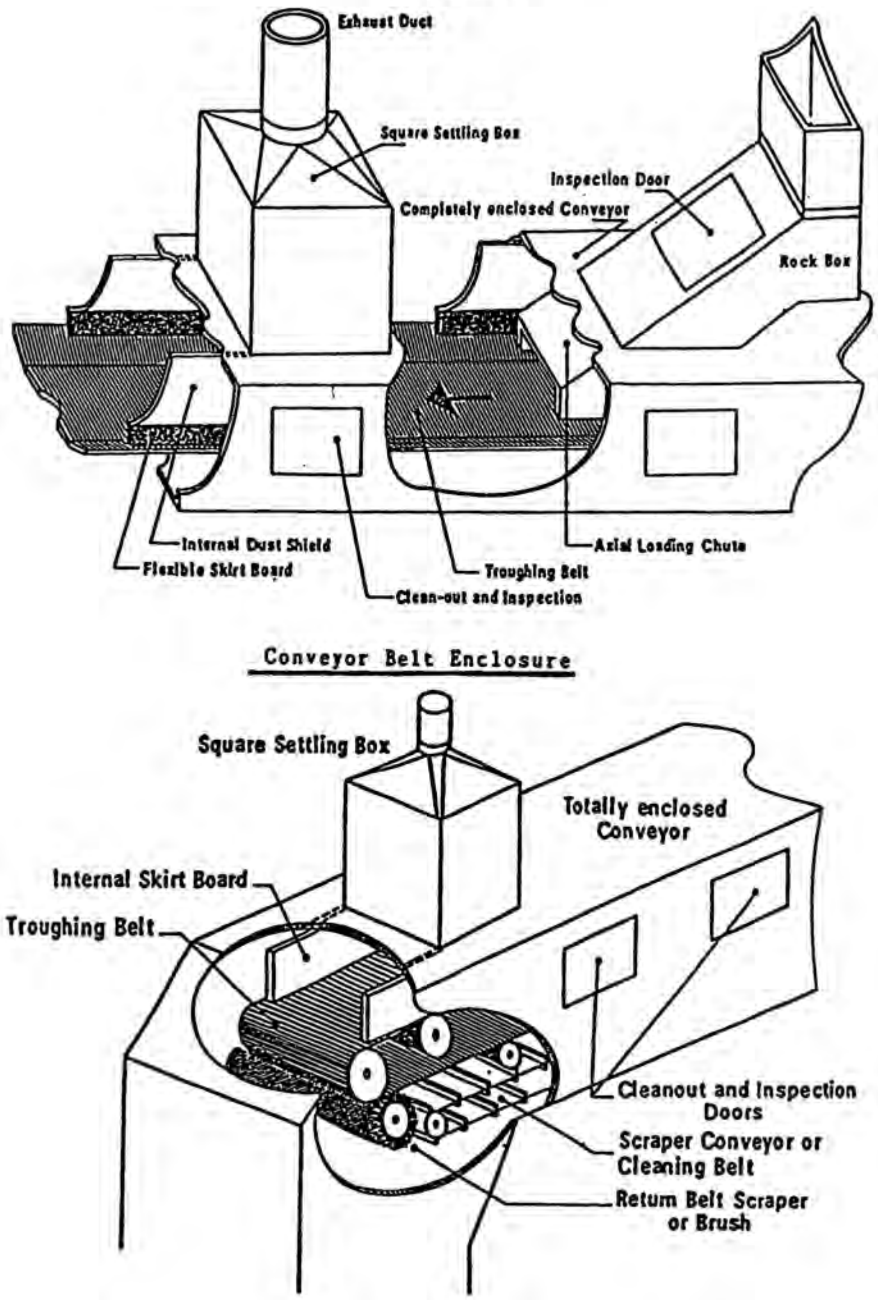
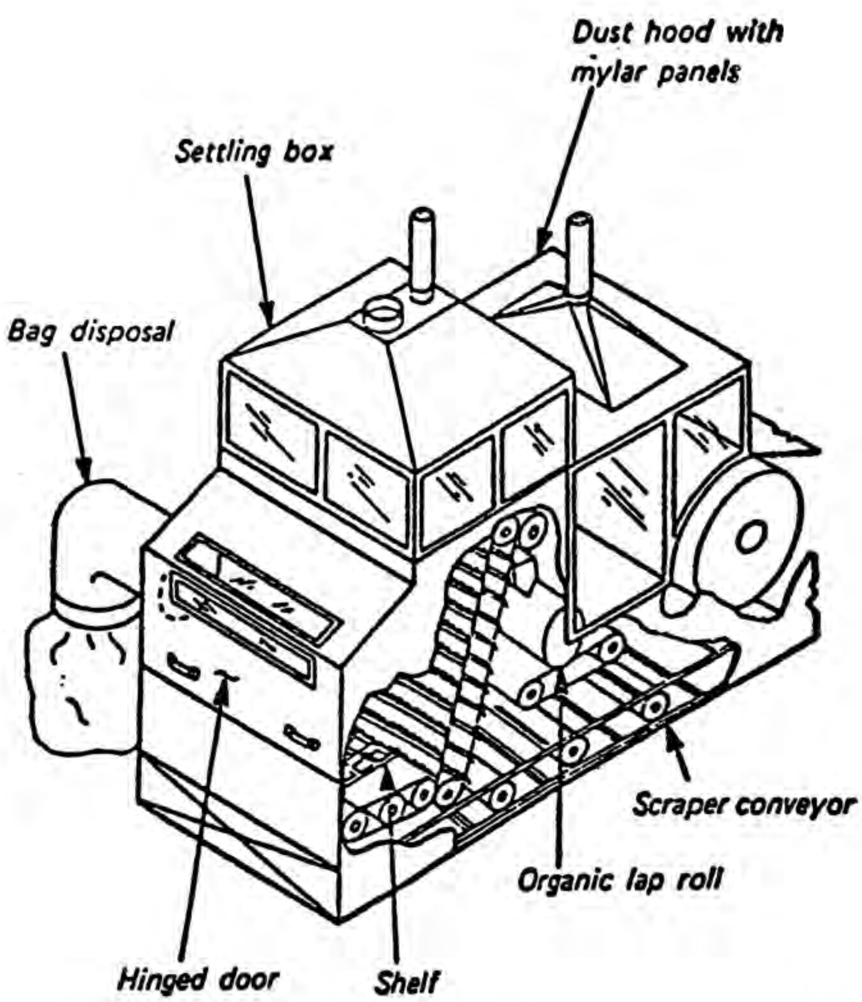


FIGURE 4 ENCLOSURE FOR TEXTILE CARDING MACHINE

Dust Control Measures: A General Overview



4.2.1 Preventive Maintenance

Assuming that care has been taken to ensure that the selected equipment has been designed to allow easy maintenance, a proper preventive maintenance schedule should be introduced to keep the equipment in good order. Air moving and cleaning devices are hard working and need good preventive maintenance. There are many examples of systems that have been satisfactorily installed, only to become inefficient soon afterwards due to lack of care.

To ensure a safe working environment, maintenance work of dust control equipments should be given priority over maintenance of the manufacturing machinery, equipment and process itself. Preventive maintenance should include the following:

Figure 1 - Schematic drawing of a basic ventilation system
Figure 2 - Bag opening station
Figure 3 - Conveyor enclosure for conveyor belt dumping or transfer
Figure 4 - Enclosure for textile carding machine

4.2.2 Ductwork System

- Proper adjustment or replacement of flexible connections between hoods and ductwork or between ductwork and fans;
- Removal of any accumulation which could create blockages and dusty conditions at different operations;
- Taking a static pressure reading at each dust hood and comparing it with the original reading. It indicates immediately if air flow-rate is what it should be at each hood. This can also be recorded on a form as shown in **Figure 5** - Duct Work Check List.

Stop any water vapour leaking into the negative or suction side of the exhaust system before it causes accumulations of dust to solidify and to create blockages.

4.2.3 Dust Collector

If not initiated automatically, cleaning of filter bags must be made on a regular basis. This is necessary in order to maintain the resistance of the bags within the range for which they have been designed. In so doing, proper air flow within the dust collection system as a whole will be maintained.

The resistance of the bags must be taken and recorded on a regular basis. In the short term, it will indicate whether bag cleaning is necessary. On the long term, it will show whether bags are blinding or if other problems occur. Bag life will vary widely from one application to another. However, bags should be replaced before they blind too much or before they start breaking on a regular basis. This is why it is important to record the date and the location of the bags being replaced.

Any accumulation of dust in the hopper of the dust collector should be cleaned. If cyclone collectors and fabric-type dust collectors are equipped with rotary air-locks, the wiper seals of these air-locks must be replaced before they start leaking abnormally. If this is not done, there would be re-entrainment of dust inside the collector and blinding of the bags.

Special care should also be given to mechanical parts that require lubrication, such as bearings. Water should be flushed from compressed air supply dryers on a regular basis in order to prevent the introduction of water into the filter bags. Forms similar to those shown on **Figures 6 and 7** can be used to record the above information.

4.2.4 Fans

If the system is designed to permit the dust to pass through the fan prior to reaching the dust collector, the fan wheel or lining must be replaced before the wheel breaks or before wear holes begin to show on fan casings. Bearings must be lubricated according to manufacturer's specifications. If the fan is belt driven, belt tension must be checked and adjusted regularly. The belt must be replaced before breakage.

4.2.5 Inspections

A procedure should be laid down for the regular inspection and testing of the complete installation. Of course, this is over and above the daily inspection which should be conducted by the operator and by the supervisor in order to detect leaks, breakages, holes in ductwork, etc. Several relatively simple techniques can be used.

Since the small particles produced by industrial processes are difficult to be seen by the naked eye, inspection can be difficult without the help of special lighting techniques to make the dust cloud visible (see **Figure 8**).

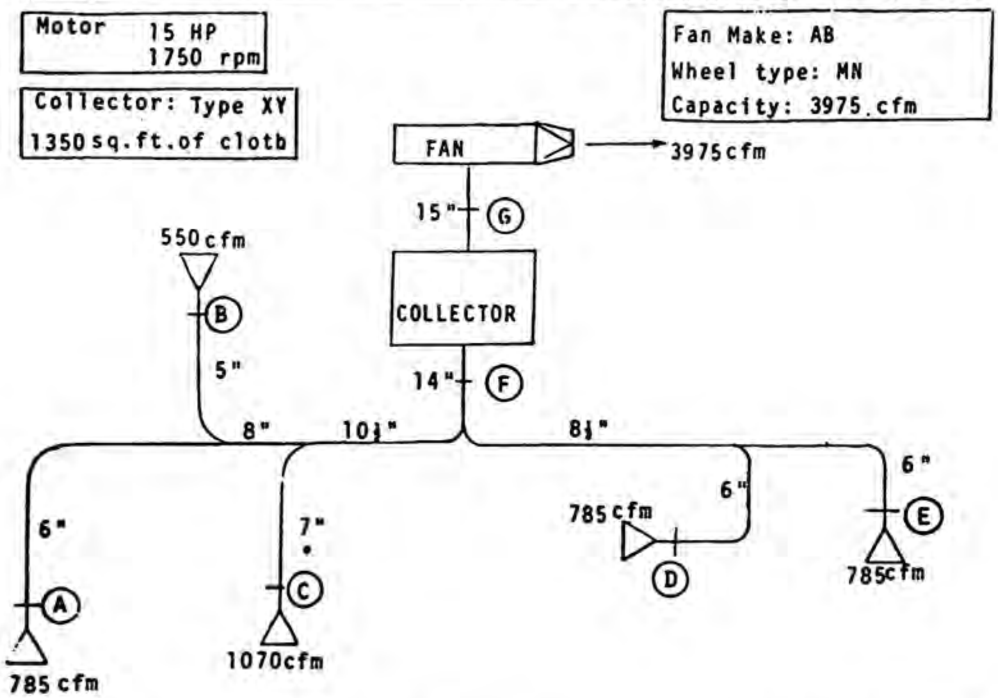
Smoke Capsules or Puffer Tube is another technique. When used, they produce a white or yellow smoke that can be used to observe flow patterns around an exhaust aperture. They may also be used to detect leaks in sealed hoods, ducting or filter units.

FIGURE 5 STATIC PRESSURE READING FORM

Dust Control Measures: A General Overview

EXHAUST SYSTEM NO ____________ CHECKED BY ______________ DATE: ____________

LOCATION ____________________ MATERIAL BEING EXHAUSTED: ______________



Test Point	CONDITION OF HOOD AND BRANCH	HOOD SUCTION Originally	HOOD SUCTION Checked
A		1.6"	
B		1.45"	
C		1.7"	
D		2.0"	
E		1.65"	
F		5"	
G		9"	
Collector resistance:	G - F =	4"	

Material collected since last check: _____ lbs

Hours of operation: ____________

Interval between shakings: ___ hrs

COMMENTS of men, and YOUR comments (Use back if necessary)

As mentioned previously, hood static pressure readings can give a very good estimate of the amount of air flowing at each hood. However, if more precise results are required, many instruments can be used, i.e. pilot tube and manometer, rotating vane anemometer, velometer, hot wire anemometer, etc.

The monitoring of workplace ambient concentrations and measurements of personal exposure to fibres, which is also a part of environmental control, is explained in detail in the chapter entitled: "Monitoring of Fibres".

4.2.6 Wet Methods and Processes

There are very few viable alternatives to exhaust ventilation, except the use of water in specific instances. Generally, this consists of the application of a fine spray directed at the source of dust, such as a cutting tool or saw, drilling, material deposited on the floor, etc. The spray must be gentle or chrysotile is likely to be distributed together with very small water droplets. Also, care must be taken to collect and properly dispose of the wetted material and/or water containing the material. Since this is usually to be carried out by a worker rather than through the use of a piece of equipment, it is essential that the workers have the know-how and tools to perform these tasks. If not, training should be provided.

Wet processing is extremely effective in reducing the possibility of dust generation. Processes which may be wetted typically have much lower dust levels than processes that must be run entirely dry.

Dust in a chrysotile cement plant, from the chrysotile cement vat to the curing tanks, can be controlled by keeping the product, equipment and floor area wet at all times. If proper tools and wet spraying are used in conjunction with immediate clean-up of debris, the finishing section of an chrysotile-cement plant can also be kept clean.

Of course, the wetting procedure requires some attention to electrical safety and other operational problems associated with water in the presence of lathes, drills, saws, etc. Many plants spray water over machining processes such as drilling and lathe cutting. This process usually produces significant reductions in fibre levels.

Due to the water droplets which frequently remain in the air during spraying, wetting in the presence of local exhaust ventilation systems is not recommended. The water spray will enter the exhaust ventilation system and produce a slurry with the asbestos, cement and other additives. When hardened, this slurry can contaminate the ventilation ducting and destroy the effectiveness of the bags in the baghouse (an industrial filter which cleans the dust from the air).

A possible problem with floor spraying is that over time, chrysotile and water paste can collect in floor cracks, forming a hard, cement-like substance. If allowed to dry out, this material can be a minor source of dust when walked on. The solution is to perform complete sluicing operations during floor cleaning.

The water used for wetting purposes may be incorporated into the process if it is appropriate for chrysotile cement application. Otherwise, it may be directed to settling tanks where the solids can settle before the slurry is removed.

For the disposal of bag house waste or other operations where large quantities of chrysotile chips and powder are present, wetting can be made significantly more effective by the use of wetting agents. These agents considerably increase the dust suppression capacity of the water and prevent emissions from the surface of disposal sites. However, wetting is not applicable everywhere.

4.3 WORK PRACTICES

The best industrial ventilation system or any other type of well engineered system designed to improve the working environment and reduce the amount of dust generated can be easily defeated by bad work practices of the operators or employees. Each person is different by nature, experience, knowledge, attitude, etc. The result of personal dust samples carried out on two employees working side-by-side, handling the same product on the same type of machine can be extremely different because of the way they work. It is very important when a dust control program is initiated in a factory that, at the same time, work practices of each employee be analyzed. There is no easy method by which the work habits of all employees can be quickly changed. Each one has to be dealt with so that within a reasonable time he begins to show improvement. The key to making employees "dust conscious" is information and training. This is discussed in another chapter of this manual.

The work practices necessary in all parts of the plant are straightforward. These work practices include wetting where such a process is applicable, clean-up of any waste generated during manufacturing, vacuuming or wet removal of all chips and small pieces throughout the plant and enforcement of straightforward regulations such as forbidding dry sweeping and the use of compressed air for cleaning purposes chrysotile. Needless to say, good work practices are as important as all other efforts made in order to provide a dust-free working environment.

FIGURE 6 BAGS INSPECTION

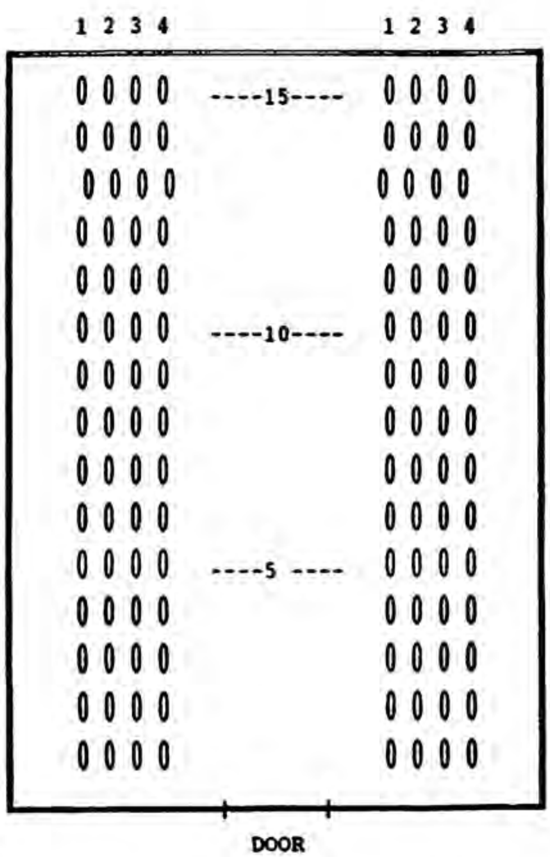
Dust Control Measures: A General Overview

Bag Collecter No. ____________

Compartment No. ____________

Broken bags ________________

Fallen bags ________________



Signed ____________________

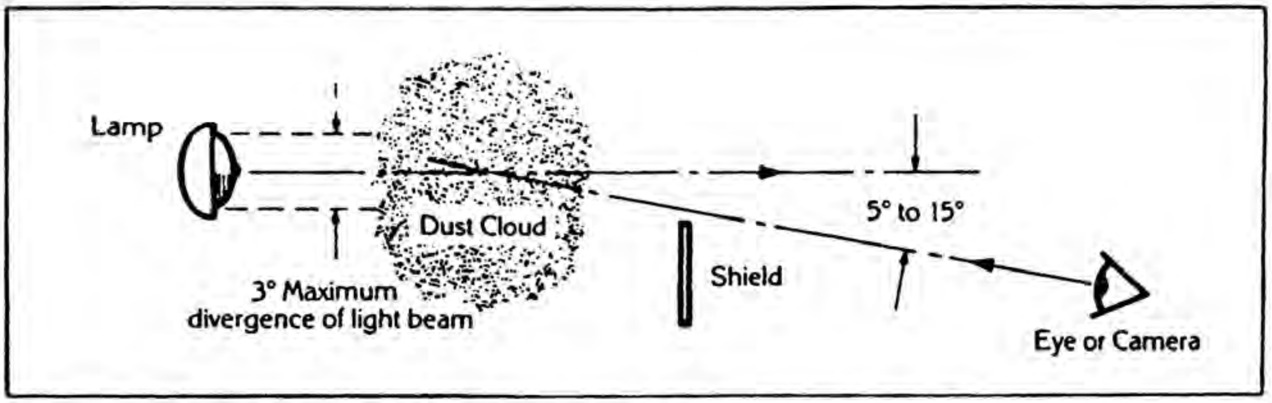
FIGURE 7 DUST COLLECTORS INSPECTION SHEET

Dust Collectors inspection Sheet

	Compartment #	#1 Debagging	# 2 Mixing	#3 Welghing	#4 Drilling	#5 Grinsing	#6	#7				
d.a.s. vaccum	(1)											
	(2)											
	(3)											
Bags resistance	(1)											
	(2)											
	(3)											
Manual switches												
Door seals	(1)											
	(2)											
	(3)											
Lighting												
Shaker belts	(1)											
	(2)											
	(3)											
Shaker motor	(1)											
	(2)											
	(3)											
Shaker bearings	(1)											
	(2)											
	(3)											
Shaker bars	(1)											
	(2)											
	(3)											
Hopper												
Screw conveyor												
Rotary air lock												
Discharge chute												
Hooks condition												
Fallen bags												
Bags with holes												
Bags full of dust												
Timer												
Compressed air												

(date) Inspected by:

FIGURE 8 TECHNIQUE FOR ILLUMINATING A DUST CLOUD WITH A TYNDALL BEAM



4.4 HOUSEKEEPING

Housekeeping is unquestionably the most important of all dust control methods. Simply cleaning-up all possible emission sources as quickly as possible is the most effective dust suppression technique. Such practices as vacuuming and wet floor cleaning not only prevent high dust levels, they also improve already clean environments. By introducing these simple housekeeping techniques, a factory can reduce dust levels by half or even three-quarters. Good housekeeping and work practices require workers' time. Because they are labour intensive rather than capital intensive, they can be used in plants working at any level of technology.

As in all other issues of health and safety at work, good housekeeping will only be achieved if both management and workers are committed to it. It is important that workers' representatives be involved in the discussions about housekeeping problems and possible solutions.

4.4.1 Storage, Transportation, Handling of Bags

Chrysotile is usually delivered in 50-kilogram, or less, pressure-packed plastic or paper bags, which are combined into 1-tonne lots of 20 bags and placed on wooden pallets. The bags are covered by shrink or stretch-wrapped plastic for extra protection during shipping and warehousing. Pallets are shipped to the chrysotile using plants in containers, by truck, rail or ship. They are then unloaded (and removed from the containers) by forklift truck, hoist, crane, hand, etc., and stored in a warehouse which is either part of the plant or located immediately adjacent to it.

Problems with respect to dust control arise immediately upon arrival of the chrysotile fibre shipment because there are bags that may be damaged in some way. This results in fibre being spilled on the floor of the truck, railroad car, vessel or inside the container. The spill should be removed by vacuuming using a HEPA (High Efficiency Particulate Air 99.97% retention at 0.3 microns) vacuum cleaner, and the workers should wear adequate respiratory protection. After taping the broken or cut bags, the pallets can be unloaded and transported to the warehouse.

It should be kept in mind that the outside of unbroken bags in the vicinity of the spill are often contaminated with fibres that must also be removed by vacuuming before the pallets are moved to the warehouse. This is most conveniently done by moving the contaminated bags to a special clean-up building adjacent to the unloading site. If contaminated bags are moved into the main storage building or into the plant, contamination is usually the result.

If the spill is a major one, the unloading crew must wear protective clothing as well as respiratory protection. Special HEPA vacuum equipment may be needed if the normal vacuum system associated with the plant cannot be used. The purpose of the special equipment is to transfer the spilled fibre into bags to be properly disposed of. In case of any spill, the truck, container, etc., used to ship the chrysotile, must be cleaned prior to leaving the plant site.

If bags are damaged while stored in the warehouse, severe contamination could occur. Corrective measures are difficult because many areas in the warehouse cannot be reached. Even under the best circumstances, a well managed warehouse should be cleaned regularly using appropriate HEPA vacuum equipment.

4.4.2 Prevention of Spillage/Spread of Contamination

Too often, the housekeeping problems are not addressed at the source. Frequently, the response to a problem which causes chrysotile to spread over the floor, workbench, etc., is to simply clean the spillage. Although this is necessary, the real effort should be put into finding and resolving the cause of the problem. Additional protection for the worker may be necessary during this period.

Think about the process. It may be possible to prevent the spillage by a change in work method, a redesign of the plant or even a change of process. It will be difficult to change long established work practices. Involvement and cooperation of the workforce is essential and retraining of operators will be needed. This provides a strategy for tackling housekeeping problems. When spillage or spread of chrysotile is found, act along the following lines:

4.4.3 Investigate

Examine the process in detail to determine the source of the spills or/spread of chrysotile. Remember that the problem may be caused by a malfunction upstream in the operation. The operator should be involved as he or she may be aware of the cause. In the meantime, additional cleaning should be introduced to cope with the problem.

4.4.4 Eliminate or Reduce Spillage

Once the cause or causes are known every effort should be made to eliminate, or if this is not possible, reduce the spillage. This can be done by:

(a) Changing the process;
(b) Changing the working method; or
(c) Providing improved containment around the process. If possible the waste collected should be automatically removed.

4.4.5 Make Cleaning Easier

If it is not possible to prevent spillage, steps should be taken to make cleaning easier. This could range from providing trays or bins to collect the spillage to making the floor below the process smooth and eliminating ledges, etc.

Successful prevention usually needs a combination of both improved plant design and working method. However, designers should make the plant suit the way people work and move rather than expect them to adapt their working methods to cope with a poorly designed machine. Even when a process is partly automated, careless or unsatisfactory work practices will often result in spillage or spread of contamination. It will help employees and supervisors if correct methods of working are laid down in written job procedures or systems of work.

4.4.6 Cleaning Techniques and Procedures

There are two vital points if cleaning is to be done well and as safely as possible. They are:

(a) The cleaning method should be dustless (in other words no chrysotile dust should escape into the air either from the cleaning action or from the cleaning equipment); and,

(b) Cleaning should be done often enough and at the appropriate time.

In order to achieve this, a combination of suitable and sufficient equipment, good procedure, adequate supervision and monitoring is needed.

The traditional method of cleaning was with a brush or broom. But this creates a dust cloud even if the brush is damp, or oiled, or water is sprinkled on the material to be swept up. This happens because dust rapidly builds up on the brush and it becomes effectively dry again. Brushing or sweeping is NOT a dustless cleaning method and should not be used.

4.4.7 Equipment and Techniques

There are different types of equipment which can achieve dustless cleaning if they are used correctly and properly maintained. They are listed below in order of preference, with an indication of the advantages and disadvantages of each one.

4.4.7.1 Fixed Vacuum Installations

Such an installation consists of a central source of suction and dust collection connected to a network of fixed pipes which have connection points for cleaning hoses and attachments in all parts of the building served. Proper design and installation is essential and should only be tackled by qualified contractors.

As with all other cleaning systems, it is important that it is readily available for use in every area which it serves. At the time of planning a system, it is necessary to balance the convenience of having numerous connection points against the additional cost of each extra point. However, the problems which will arise from an under-designed system suggest that it is better to have too many connection points rather than too few.

Cleaning should be organized to prevent too many points being used at the same time. If too many are used together they will not work effectively because the suction will be too low.

The advantages and disadvantages of fixed vacuum cleaning installations can be summarized as follows:

ADVANTAGES	DISADVANTAGES
• Relatively little maintenance • Centralized collection of waste • Reasonable running costs • Easy operation	• High initials costs • Failure can cause relatively serious problems (all connections out of action) • Still need back-up by portable systems

4.4.7.2 Portable Vacuum Cleaning Equipment

This type of equipment is self-contained having its own suction fan, filter unit and dust collection bag. There must be enough of them so that they are readily available in all areas that require service. They also need to be sufficiently portable to allow cleaning of difficult and restricted spaces. The number will depend to some extent on the way cleaning is organized.

ADVANTAGES	DISADVANTAGES
• Lower capital cost • More versatile and flexible	• Continual maintenance • Potential hygiene problems during dust bag changing • Trailing electric cables

4.4.7.3 Mobile Floor Cleaners

This type of equipment usually includes a powerful suction and filtration unit connected to a floor cleaning attachment. Some types also have a rotary brush. Not all types of floor cleaners will be capable of dustless cleaning or will have an adequate standard of filtration. Therefore careful assessment is needed when selecting such equipment for use in asbestos contaminated areas.

Despite these reservations, such equipment may be the only practical way of cleaning large floor areas and gangways in a reasonable time. They should NOT, however, be used as an alternative to portable vacuum cleaners, for other types of cleaning.

ADVANTAGES	DISADVANTAGES
• Clean large areas quickly	• Some types may not be dustless • Doubtful filtration standard • Emptying waste collection bins/trays is dusty and will require the use of protective equipment

4.4.7.4 Other Techniques

Wet cleaning techniques can be dustless, providing that they are genuinely “wet” and not just “damp”. The waste to be cleaned up must be thoroughly wetted and kept wet until it is in a sealed container. The wet waste should be scraped into a collection tray or bin. Alternatively, wet waste can be washed or sucked into a collection sump and disposed of as liquid waste by a specialist contractor.

4.4.8 Chrysotile and Asbestos Waste

Waste collected during cleaning should be put into a suitable container such as a heavy duty plastic bag. The container should be closed and sealed and should be labelled “Asbestos waste”. The label should also indicate the type of asbestos if required by local authorities. The local waste disposal authority should be consulted for advice on correct methods of disposal.

4.4.9 Procedure

Having ensured that the right equipment and techniques are available for cleaning without dust, it is essential that they are properly used and maintained. For this to happen, employees must know what they have to do and how to do it. Supervisors/managers must monitor how well it is done. It will usually help if the procedures are laid down as a written system of work. This should deal with responsibilities for cleaning, maintenance of equipment and monitoring in general terms. Details of how and when to clean particular areas can be provided in separate cleaning schedules.

4.4.10 Responsibility for Cleaning

The responsibility can be placed on individual employees, a specialist employee (or team) or a combination of these. One system cannot be said to be better than the others, rather the allocation of employees to cleaning duties needs to be matched to the equipment and techniques provided. The most important point is that the responsibility should be clearly laid down in written procedures and schedules.

4.4.11 Cleaning Schedule

Cleaning schedules should be prepared for all areas, machines, etc. Therefore, every effort should be made when planning cleaning procedures to stagger the cleaning times throughout the premises. There are advantages for both cleaners and supervisors if cleaning schedules are displayed at the machine, in the area to which they relate.

4.4.12 Improvements – A Case Study

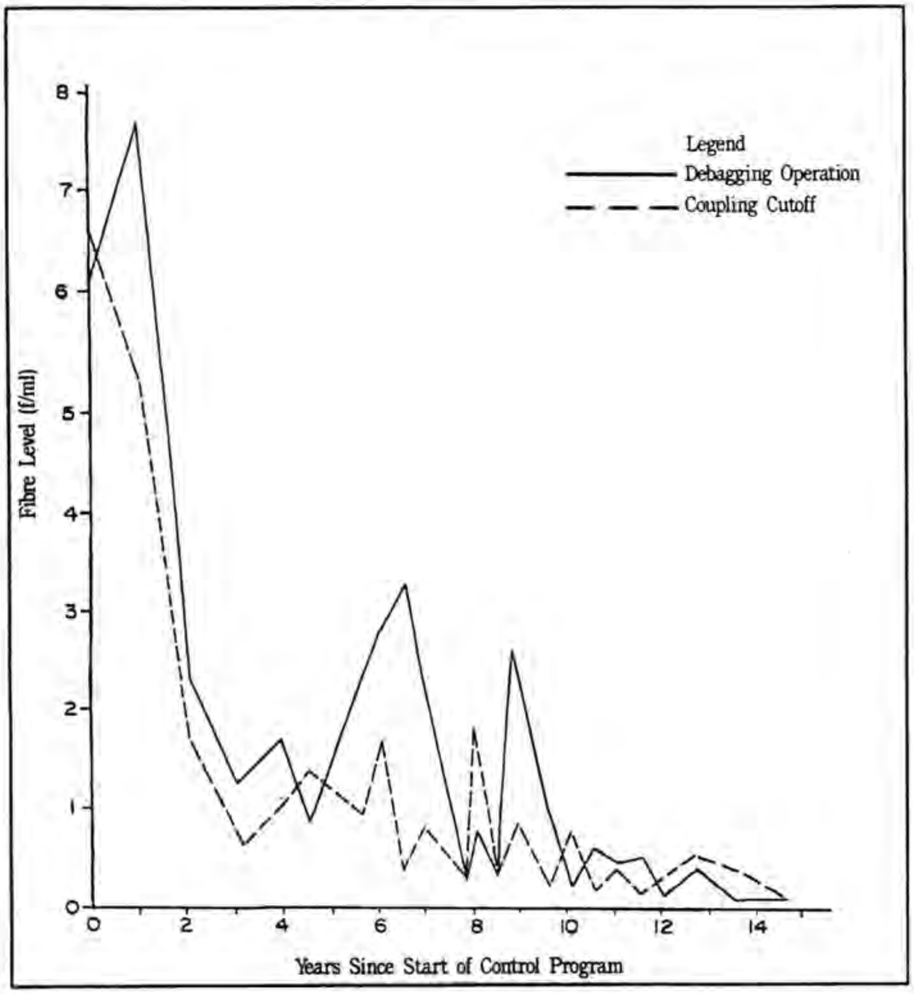
Figure 9 show historical behaviour in 1983 and 1984 of two work stations at a single asbestos-cement pipe plant. This data shows that dust control is an evolving process. Engineering controls, work practices and housekeeping all contribute to the changes and improvements achieved during the 14 years of operation. As the figure indicates, in later yaers the control was sufficiently effective that the dust level were at or below the level detectable bye the optical microscope method.

4.5 PERSONAL PROTECTIVE DEVICES

In many situations, particularly those dealing with maintenance, repair and equipment failures, it is not possible to ensure low dust levels at all times in the plant environment. As a result, respirators and special clothing may occasionally be required. Use of respirators should be regarded as a temporary or emergency measure only and not as an alternative to other control procedures. The more common types of respirators can be uncomfortable for extended periods. In fact, workers frequently refuse to wear them except for short periods.

For emissions which are above the recommended permissible exposure limit value, appropriate respirators fitted with replaceable filters are necessary. Workers should be informed of when and why a respirator must be used, and the importance of using it continuously and properly. The correct procedures for the use and verification of protective equipment should be demonstrated. The subject of "Personal Protective Equipment" is thoroughly covered in Section 7.

FIGURE 9 HISTORY OF DUST CONTROL AT AN ASBESTOS-CEMENT PLANT



The dust levels were brought down to technically feasible lower levels by improving environmental engineering controls at the work place. In addition regular audit of the environmental control systems and educating the employees on the importance of environmental surveillance have helped achieve such low dust concentration levels at the workplace.

5

Dust Control Processes using Chrysotile Fibres

5. Dust Control for Processes Using Chrysotile Fibres

5.1 CHRYSOTILE-CEMENT (C/C) MANUFACTURING

5.1.1 C/C Manufacturing Process

The manufacturing of chrysotile-cement sheet and pipe represents over 90% of the world chrysotile production. As mentioned previously, all asbestos-cement manufactures use **chrysotile**. The processes for sheet and pipe are similar and consist of a number of operations in sequence, i.e. 1) fibre debagging, 2) fibre preparation, 3) chrysotile-cement slurry preparation [some cement is replaced by silica when autoclaving is part of the process], 4) sheet or pipe forming, 5) curing, 6) finishing, and 7) recycling or disposing of solid waste material or effluent water. In some areas, paper or textile fibres are added to the chrysotile-cement blend. This does not constitute a health hazard to the worker and, therefore, is not covered in this report.

In preparation for the first process step, the chrysotile bags must be transported to the debagging station either from the warehouse or from the storage area of the plant. This is usually done by forklift truck or hand-drawn wagon. Under normal circumstances, i.e. when the bags are not damaged, this presents no problem from a dust control point of view. However, in a few cases the bags that arrive at the debagging station are cut or broken. If this situation exists in a plant, it must be corrected immediately. The damaged bags must be repaired or rebagged if necessary. This should be done by a crew trained and equipped for this purpose. Failure to do so could expose some workers in the plant to dust levels above the threshold limit value (TLV).

It is often recommended to clean-up spilled fibre by applying a spray of water, followed by sweeping. Obviously, the water is meant to wet the fibre and suppress dust during sweeping. However, wet sweeping involves a number of potential problems that the worker performing this task must keep in mind. For example, if the spray of water is too strong, dust is raised together with airborne water droplets. This will settle in another area and become a problem after the water has dried out. Also, wet sweeping may not achieve proper cleaning for acceptable dust control. If not enough water is used, a great deal of dust can still be generated. When too much water is used, a layer of wet fibre remains on the floor and becomes a source of dust after drying. Similarly, unless the floor is flat and smooth, some wetted chrysotile will remain behind after sweeping and become a problem after the water has evaporated.

For this reason, it is recommended to replace wet sweeping with vacuum cleaning (HEPA vacuum cleaner or hose connected to the bag house) except for areas that are constantly kept wet, or can actually be washed, such as the areas around the sheet or pipe machine.

A bag house is an industrial vacuum system consisting of several cloth filters (bags) mounted in an enclosure (house), a fan and appropriate ducting. The fan draws dusty air through the ducts and through the cloth filters, where the dust is collected. It is an important aspect of the bag house operation that the air being exhausted is clean and, therefore, does not contaminate the environment outside the plant.

5.1.2 Fibre Debagging

The first processing step involves the debagging of the fibre and transfer to the fiberizing equipment. If for any reason this is done improperly or if the equipment is not suitable, debagging becomes a major source of dust and, therefore, a major hazard for the worker.

The best arrangement for debagging is obviously equipment that does so without involvement of manual steps. There are a number of automatic debaggers available in different sizes suitable for small, medium or large operations. (see **Section 4, Figure 2**)

This equipment, when operating properly, provides excellent protection for the worker. Unfortunately, the equipment can malfunction or be improperly operated. If this happens, manual steps are necessary to correct the situation and the risks to the worker may be severe.

For example, automatic debaggers that are open for constant access because of problems with the bag cutting and fibre removal mechanism of the machine may result in the release of large quantities of fibre. This is an improper operation and steps should be taken immediately to correct the situation. Also, an automatic debagger is designed to shred the plastic bags and deposit the shredded material in a plastic sleeve or bag. If this is not done properly, intervention by the worker is required which can result in hazardous exposure. (See **Section 4, Figure 2**)

Automatic debaggers are usually found in modern plants that are properly designed to operate with little generation of dust. In the majority of cases, debagging is carried out by hand. Properly designed manual debagging stations used for this purpose consist of a table covered by a hood. The hood should cover both sides and the back of the space above the table, leaving only an adequate opening at the front. These hoods require exhaust ventilation, i.e. they must be connected to a bag house (cloth filter) with a capacity of approximately 3,000 cubic feet per minute. This is necessary to achieve the required velocity for the air being drawn into the hood opening, which should be about 200 feet per minute.

During the manual debagging operation, a bag of a chrysotile is placed underneath the hood of the station, the plastic bag is removed by cutting and the chrysotile is pushed into a discharge port. The plastic bag is then deposited into a disposal bag or shredder directly attached to the hood of the debagger. This means that the plastic bag is not removed from the underneath the hood in order to avoid spreading dust adhering to the bag. It is most inappropriate to remove bags from the hood and to manipulate them (shaking, flattening, compressing, etc.) or to stack them outside the hood. This type of handling will result in the formation of a great deal of dust and constitutes a severe hazard for the worker. The proper procedure is to place bags into a plastic sleeve, bag or container. This should be followed by burning or safe disposal (i.e. burial) at an approved landfill site. Used chrysotile bags must not be reused for other purposes.

A hood of better design resembles a glove box, that is, its front opening is covered by glass or a plastic sheet fitted with long sleeve gloves. In this case the bags are placed onto the table through a side door than can be completely closed after this step. The operator can reach the bag by using the gloves to cut the bag and push the chrysotile cake through the discharge port. The empty bags can be deposited into a collection bag or into a shredder. This arrangement has the advantage that the chances of exposure to dust for the worker are greatly reduced. Also, considerably less air capacity is needed which reduces the cost of this operation.

For a more automated version of this type of debagging station, mechanical bag cutters are used to replace the hand operation inside the hood.

Manual debagging stations can provide adequate protection if they are of correct design incorporating a hood and exhaust ventilation. However, this is often not the case and all sorts of poorly constructed debagging stations exist. Some of these lack proper hoods and have inadequate exhaust ventilation. With this type of arrangement, dust is created in a number of ways. Firstly, fibre is usually spilled when the bags are cut by hand and when the fibre cake is broken up to be pushed into the discharge port. Secondly, more dust is generated when the empty bags are handled and stored adjacent to the hood. Obviously, these debagging stations provide no protection for the worker even when the separation of plastic bag from the fibre cake takes place under the hood.

In some cases, there is no debagging station and the fibre is debagged by hand and fed directly into a blender or fiberizer through the side or from the top. Feeding from the top is done either by conveyor belt or through a port from the floor above. This obliges the worker to cut and empty the bag outside the entrance to the conveyor, blender, or fiberizer. Since this is often done on the floor rather than on a table these operations are dusty and should not be tolerated.

Some improvement of this procedure has been achieved by supplying chrysotile in water soluble paper bags. These bags can be fed into the fiberizer without opening them. Therefore, there is no dust and the worker is protected. This procedure is used primarily for the manufacture of chrysotile-cement sheet because paper fibres are normally used to improve the impact resistance of the sheet. A hydropulper is particularly suitable for this method of fiberizing.

5.1.3 Fibre Preparation (Fiberizing)

The next step of the process after debagging is fibre treatment usually referred to as fiberizing or opening of the fibre. It typically starts with the mechanical or pneumatic conveying of the fibre to a fiberizer, sometimes with prior blending. The purpose of the fiberizing process is to reduce the diameter of the fibre bundles which increases their ability to act as reinforcing agent for cement. This is done using various types of equipment using dry fibre, wetted fibre or aqueous slurry.

The most common of these are the kollergang (dry or wetted fibre), the hollander (aqueous slurry), the hydropulper (aqueous slurry), the disintegrator (dry fibre) and the willow (dry fibre). These can be used alone or in combination, depending upon the perceived technical advantages.

The kollergang may be operated with dry fibre or with fibre to which about 30% water has been added. Its use is usually followed by the hollander or a hydropulper. However, both the hollander and the hydropulper may be used alone. With dry kollergang treatment, one or two passes through a disintegrator are often used ahead of the hollander. For wet kollergang treatment, the disintegrator may be bypassed. There are also completely dry fiberizing procedures in use which rely entirely on disintegrator or other devices, such as the willow.

The fibre treated by the kollergang or one of the dry fiberizers may be stored in a silo prior to the next step. This depends on the size of the operation, the number of fibre grades used, etc.

Dust free operation of the kollergang requires that it is enclosed, even when water is added to the fibre. In addition, the enclosure or hood must be connected to an exhaust ventilation system consisting of a bag house (cloth filter) and a suitable fan. This places the space within the kollergang under negative pressure. Therefore, dust is not released when the door of the hood is opened to inspect the internal parts of the kollergang, etc. Consequently, workers are not exposed to dust under these circumstances.

The fibre treated in the kollergang, must be conveyed to the next piece of equipment or the silo using an enclosed conveyor or another safe device. It is improper to discharge the treated fibre onto the floor to be transported manually to the next piece of equipment. This procedure could release a great deal of dust into the air and be a potential hazard to the workers in the plant.

Both the hollander and the hydropulper are generally used to blend chrysotile fibre and cement at the end of the fiberizing stage. This type of blending is also done by other devices, such as a pump running in a conical tank, etc. This fibre cement slurry is further blended with water, usually in a slurry vat. The slurry prepared in this manner is fed to the chrysotile-cement machine. In some instances a small hydropulper is used following the slurry vat to assure that the slurry is sufficiently homogeneous and does not damage the felt of the chrysotile-cement machine.

Since both the hollander and the hydropulper are using a chrysotile, or chrysotile-cement slurry, there is no need for a cover other than to prevent material from splashing. Even if this occurs, splashed material can be removed with water and there should be no exposure to dust. It should, however, be noted that the slurries can dry out and dust can then become airborne due to foot or vehicle traffic. A similar comment can be made for the slurry vat and the small hydropulper which usually present no problem.

5.1.4 The Formation of Chrysotile-Cement Sheet and Pipe

The formation of sheet and pipe is obviously the heart of the process. For sheet manufacturing, the conventional Hatschek machine is used. It consists of a series of tanks (up to five, usually three), each fitted with a rotating sieve cylinder and each filled with the chrysotile-cement slurry prepared during the previous process stage. As the sieve cylinder rotates in the slurry, a thin layer of chrysotile-cement is continuously screened from the slurry and transferred to the endless felt of the machine. By running over suction boxes, the amount of water in the chrysotile-cement layer is reduced further and the layer is transferred to a cylinder drum.

When the layers of chrysotile-cement being wrapped around the cylinder drum have reached the required thickness, the machine stops automatically and the layer is cut parallel to the axis of the cylinder to form a sheet. The machine then restarts and repeats the process.

After forming, the uncured (green) sheets may be cut to the desired dimension on the discharge belt of the machine or moved to another location to be cut. This avoids the necessity of cutting sheets after curing and drying, which is not a recommended procedure because it tends to create a great deal of dust. The material cut from the uncured sheet is returned to the wet end of the machine to be dispersed in water and returned to the process. Process water removed by the sieve cylinders and the suction boxes is reused for the process after passing through settling tanks. This whole process is environmentally friendly.

The uncured sheets are stacked between steel sheets and they may be corrugated by a separate process prior to stacking. Both types of sheet may be pressed. The sheets are allowed to cure for a limited period of time before destacking (removal of steel sheets) and further curing. At this stage, the chrysotile-cement sheets are still wet and it is most unlikely that workers in this area will be exposed to dust. However, good housekeeping is required to remove broken pieces of chrysotile-cement sheet. Considering that the formation of sheet is entirely a wet process, it is not surprising that dust is created only in exceptional circumstances. However, some care is required to avoid or control spills around the machine, particularly from return waste water. When spills occur, they can be cleaned-up relatively easily by washing with water. In fact, that is the method recommended to prevent creation of dust around the machine.

Flat sheet can be removed from the process prior to stacking and used for the production of hand moulded pieces, such as special roofing parts, flower pots, etc. This operation does not create dust and therefore, does not constitute a health risk for the workers as long as moulding and cutting is done before the sheets dry out.

The manufacturing of chrysotile-cement pipe is in many respects similar to the manufacturing of sheet. In fact, up to the slurry vat, the two processes are identical. The actual pipe making machine may have only one or two sieve cylinder vats and the felt has a different configuration. Alternatively, two felts are used. Also, the cylinder drum is replaced by a mandrel onto which the chrysotile-cement layer is wound. Different diameter mandrels are used to produce different diameter pipes as well as pipe couplings.

After forming the pipe on the mandrel, both are removed from the machine, replaced by a new mandrel and the entire process is repeated. The pipe is then removed from the mandrel by various methods and transferred to a low temperature curing tunnel. Because the process is wet, no dust is created and, therefore, this part of the process does not present a risk to the worker.

Even in a well-operated plant, the transfer points for various materials are vulnerable to spills that require prompt and efficient clean-up. It is for this reason that mechanical solutions, such as enclosures, should be designed into the process.

5.1.5 Sheet and Pipe Curing

The curing of chrysotile-cement sheet and pipe is a relatively simple process and by definition involves the use of water, steam or a moist atmosphere. Therefore, it is unlikely that dust is generated during this process as long as normal precautions are taken.

After initial curing in a stack, chrysotile-cement sheet is usually cured by storage under humid conditions produced by water spray or steam. Chrysotile-cement sheet can also be cured by autoclaving, but this procedure is not often used.

Chrysotile-cement pipes are normally pre-cured in curing tunnels which are heated to accelerate the hardening process. For this purpose, the pipes are moved through the tunnel on a roller conveyor. The pipes are rotated on the roller conveyor to prevent deformation. Pipes with a large diameter may be fitted with wooden mandrels or end plugs for the same reason.

After pre-curing, the pipes are usually submerged in water tanks for a period of time which varies according to the temperature of the water. Alternatively, the pipes are stacked and constantly sprayed with water. Also, pipes are often cured by autoclaving which requires special equipment but is accomplished in a much shorter period of time. Furthermore, autoclaved pipe is considered to be more resistant to attack by aggressive soil because calcium hydroxide (free lime) has been removed by reaction with silica. Hence, silica is only used in pipe manufacturing when the pipe is subsequently autoclaved. Silica should be used with precautionary measures.

5.1.6 Cutting and Finishing of Sheet and Pipe

As mentioned above, chrysotile-cement sheet should be cut before curing. However, in some plants, cured chrysotile-cement sheet (hard sheet) is trimmed to size, or small pieces are cut from larger ones, using circular saws. This is usually an extremely dusty operation even when the sheets are wetted, and should take place in a separate location with special equipment and mandatory personal respiratory protection. If hard sheet is cut by saws, properly designed hoods and exhaust ventilation should be provided. Alternatively, water can be used for dust suppression by directing a stream of water or fog directly onto the saw blade or cutting tool. Obviously, provisions for collecting and discarding the contaminated water must be available.

Even under these circumstances, chrysotile-cement dust and debris can collect around the equipment. Clean-up of this material should be carried out on a frequent basis using wet sweeping, HEPA (High Efficiency Particulate Air) vacuum cleaners or hoses attached to the bag house. Clean-up crews must wear approved HEPA respirators when performing vacuuming operations.

It must also be kept in mind that exhaust ventilation has the purpose of removing and collecting large quantities of chrysotile-cement dust. This dust must be collected and disposed of by proper procedures. If this point is neglected, dust could become airborne and the workers in that particular area unintentionally exposed to an unacceptable situation.

Under normal circumstances, the ends of chrysotile-cement pipes are cut by saws in one stage and finished on a lathe in another. Pipes are also cut into smaller pieces and finished on a separate lathe to produce pipe couplings. There are several modifications that can be introduced to reduce or eliminate the dust created during these operations, such as appropriate ventilation hoods. For example, the pipes can be used in a wet condition because wet chrysotile-cement generates less dust. Also, the end cutting and lathing operations can be performed in one stage using the lathe only. The lathe produces chips and shavings instead of dust particularly when cutting wet material. In addition, water may be sprayed onto the cutting tool to further reduce the chance of dust formation.

Finally, both saws and lathes must be fitted with properly designed hoods and exhaust ventilation systems. This applies as well to the cutting, finishing and drilling of couplings. Automatic and semi-automatic equipment is particularly suited for this purpose.

Care must be taken when performing maintenance and repair work on equipment. The crew involved must wear protective clothing (disposable coveralls or coveralls that can be laundered) as well as approved HEPA personal respirators. (See Section 7)

Of particular concern is the material collected in bag houses which are often located outside the plant building and tend to escape attention. If the material collected by the bag house is allowed to spill onto the ground, a new source of dust is created that can be hazardous to the workers as well as personnel around the plant. Bag houses must have properly designed collecting devices (containers) that allow removal of chrysotile-cement dust without creating a problem.

5.1.7 Disposal of Solid Waste and Effluent Water

In many situations, it is possible to grind all the solid chrysotile-cement waste generated in the plant and return it to the sheet or pipe process. In some cases it is not possible. In such cases, this material should be wetted, collected and disposed of. The recommended practice calls for disposal and burial in a landfill site approved by regulatory agencies. It is essential that the crew performing this task be trained to recognize hazards due to high dust levels and to introduce appropriate corrective measures.

The handling of this material can present a problem to the worker, particularly when it is allowed to dry out. Therefore, the crew removing this material must receive proper training, equipment and protective clothing, i.e. disposable coveralls or coveralls that will be laundered.

As in all cases where dusty material must be handled, showers and facilities for the cleaning, laundering or disposal of protective clothing should be made available. (see Section 7 – **APPENDIX 1**)

Most process water can be collected in silos and reused after a simple settling process. However, the solids settling in silos and settling tanks could present a problem. If this material cannot be returned to the process, steps must be taken to dispose of it in a proper manner, such as to lagoon this water and direct the settled material to an approved landfill site. This task should be performed by trained personnel capable of handling potentially hazardous situations.

5.2 FIELD INSTALLATION OF CHRYSOTILE-CEMENT SHEET AND PIPE

5.2.1 Handling / Transportation

When performed carefully with the use of proper equipment, there should be no dust problem during the transport of chrysotile-cement sheet or pipe from the plant or warehouse to the construction or installation site. Nevertheless, as with other construction materials, normal precautions must be taken to prevent the creation of dust. For example, scraping by hoist chains and other abrasions must be avoided. Also, any accidental breakage must be removed immediately to avoid the creation of dust by vehicles driving over the broken material.

5.2.2 Installation - C/C Sheet

Special precautions must be taken when chrysotile-cement products are drilled or cut during the installation process. These actions may produce a considerable amount of dust if proper tools are not used or if they are performed by untrained workers. In order to avoid drilling and cutting at construction sites, many manufacturers are pre-cutting or pre-drilling their product prior to leaving the factory.

A specific problem exists with respect to the installation of chrysotile-cement sheets. This problem is caused by a process called mitring, i.e. cutting a mitre at one corner or the top and bottom corners on opposite sides. This is done to avoid an overlap of four corners and the possibility of rain penetrating at this point.

In some cases, mitring is done at the chrysotile-cement plant. Three types of sheets must be produced to cover the ends as well as the edges of the walls and the roof of the building, i.e. sheets with one corner mitred, sheets with two corners mitred as well as sheets without mitred corners. Since this requires considerable planning during manufacturing, warehousing and installation and because different mitre angles may be required, mitring is often done at the construction site.

Because of the potential hazards involved, manufacturers recommend that high-speed tools never be used when cutting or drilling chrysotile-cement products. Where cutting must be carried out at the construction site, hand tools should be used as much as possible. For example, mitring can be done by using shears that break the chrysotile-cement into chips. (Wetting during the process is strongly recommended.)

Alternatively, simple hand saws with large teeth that produce a very coarse dust can be used. Also, the drilling of holes (when punching is not possible) can be performed by a hand drill that produces coarse shavings because of the low speed (**Figure 1**). These materials can be cleaned-up by wet sweeping and require no special precautions.

FIGURE 1 -HAND TOOLS

If disc grinders, hand-held power saws, etc are used in the field, a centrally located, separate building should be provided. Each piece of equipment should be fitted with a properly designed hood that is connected to a HEPA vacuum system. In general, abrasive or masonry disc grinders should never be used unless equipped with a HEPA vacuum system. If so equipped, there is no need for workers to wear HEPA respirators. However, such equipment should be provided to workers upon request.

If a vacuum system is not available, water should be used for dust suppression. When using this approach, the chrysotile-cement sheets should be wetted and water should be sprayed onto the saw blades. The blade should run at the lowest speed possible and a blade with large teeth should be chosen. This produces large cuttings rather than fine dust. Again, chips and shavings can be cleaned-up by wet sweeping. The hand-held, rotating band saw, developed by the Neuss Institute in Germany, may be used for wet cutting because it operates at a low speed and the saw teeth are large.

A good procedure for installing chrysotile-cement sheet is the offsetting system. This means that the adjacent sheets in the first course (layer of chrysotile-cement sheet) of a wall or roof are overlapped as usual, but the next course is offset, one corrugation to the left or right. The third course is offset two corrugations etc. For this method, one or two corrugations must be trimmed from the front sheets of the second or third course. This should be done by scoring and breaking the sheet instead of sawing. The break produced is not as smooth as a saw cut, but this is a small price to pay for avoiding a potential dust problem. In regard to this approach, it is possible to punch a hole by using the bolt intended for securing the sheet. Although the holes produced in this manner are not as even and uniform as drilled holes, there seems to be no problem in terms of appearance or safety.

5.2.3 Installation - C/C Pipe

During the installation of chrysotile-cement pipe, it is frequently necessary to shorten the length of pipes or remove broken pipe ends. This is done by hand tools that either crack or cut the pipes. There is a minimal dust generated when pipes are cracked as cutting produces relatively large chips because of the low speed at which the cutting tool operates. As a further precaution, the pipes should be wetted and appropriate personal protective equipment worn by the workers. Obviously, all chrysotile-cement debris must be collected and properly disposed of. The use of high speed abrasive disc saws for cutting pipe in the field is not recommended, regardless of whether new installations or repairs are involved.

The ends of the pipes that are cut are usually reduced in diameter using a manual lathe. Where this is not required, the edges of the pipe may be beveled manually using a rasp. In both cases, relatively large chips of chrysotile-cement are created. Manual lathes can also be used to cut grooves into couplings. This is usually done for repair jobs rather than new installations. In this connection, removal of couplings from old pipes should be done by chiseling to avoid creating dust.

If holes must be cut into pipes to install connections, this may be done manually by using simple tools. There are also manually and low-speed power operated machines for the boring of pipes that carry water under pressure. It is not expected that dust problems arise during these operations as long as normal precautions are taken, including appropriate clean-up.

5.2.4 Cleaning-up

At the end of installation, the work area should be cleaned of any chrysotile-cement dust or debris. In particular:

A) Waste and debris must be cleaned-up and disposed of as soon as possible. Debris which is liable to generate dust should be placed in closed containers to prevent this from happening (e.g. heavy duty polyethylene bags).

When the container is full, it should be effectively sealed, the outside cleaned and placed in a separate storage area for disposal. Containers should be labeled to show that asbestos is present. Larger pieces of chrysotile-cement, including whole sheets, should not be broken or cut for disposal in plastic sacks. If they are dusty or crumbly, they should be wetted and wrapped. These materials should be carefully transferred to covered lorries or skips.

B) External surfaces of waste containers must be cleaned before removal from the work area.

C) All surfaces in the work area must be cleaned by a suitable dustless method. Where practicable, use a vacuum cleaner fitted with a high efficiency filter to collect dust. Where this is not appropriate, wet dust and debris thoroughly, (i.e. not merely sprinkled with water) before brushing or shoveling into strong plastic bags. Appropriate personnel respirators should be made available upon request.

5.3 FRICTION MATERIALS MANUFACTURING

Friction materials, such as brake linings or brake pads, are usually manufactured by variations of the same dry process. This involves material preparation resulting in the mixing of dry components, preforming this mixture in cold presses, hot pressing and curing the preformed pieces, and cutting, grinding, drilling as well as finishing. The pieces can be shaped during or after hot pressing. (There are also so-called wet methods and extrusion methods.)

The dry mixture consists of three major components, 1) the binder, usually phenolic resin including extenders, 2) the reinforcing material, normally chrysotile fibres, and 3) functional fillers to improve the properties or performance of the final product. The latter are a mixture of metallic materials (e.g. lead, brass), non-metallic materials (e.g. alumina, barite), and carbonaceous materials (e.g. graphite, gilsonite).

Chrysotile fibres used in most friction products is received in 50 kg bags on pallets of 20 or 40 bags. (Other types of asbestos, i.e. crocidolite or blue asbestos, or amosite or brown asbestos are no longer used in the manufacture of friction materials.) For receiving and warehousing chrysotile, the same precautions must be applied that have been discussed for chrysotile-cement manufacture. Other materials, such as resin or functional fillers, are generally received in bags or drums and must be stored in a warehouse or in the plant. Some of these materials are toxic and care must be taken not to generate dust during storage and handling.

5.3.1. Material Preparation

Initially, the chrysotile is debagged as in other processes. This is done by a variety of methods ranging from manual operations with hoods to automated debagging stations. Debagging of chrysotile, as for any mineral (silica) presents a special problem and appropriate precautions must be taken to avoid creating dust. This involves the establishment of a proper debagging station. (See **Section 4, Figure 2**)

Debagging is followed by a dry opening step which requires an enclosure to avoid the creation of dust. The dry methods used for this purpose, such as cage milling and hammer milling, unfortunately have a tendency to be dusty. This can be avoided by connecting the opener to a bag house that provides negative pressure.

Various chrysotile grades are often used for manufacturing friction materials. These grades may be combined prior to opening to achieve thorough blending. Alternatively, the different fibre grades may be opened separately.

Chrysotile and other raw materials are then weighed and blended. The resulting moulding compound is collected in drums. Depending on the procedure and equipment used, this can be an extremely dusty process.

Debagging, opening and blending can be carried out in a single process. However, in actual practice, a batch process is often used for these steps. This means that the various ingredients used in each step are weighed out separately or combined. Similarly, the feeding of all materials to the blender must be carried out under a ventilated hood.

The entire material preparation procedure can be potentially very dusty. Obviously, the process should be designed to minimize the number of manual handling steps and one possibility is to automate the entire process. For this purpose, all materials including chrysotile should be debagged automatically, and stored in sealed bins. All materials should then be weighed and blended automatically, and the resulting mixture should again be collected in closed containers. These containers should be mobile so that they can be transported to the performing presses without creating dust. Alternatively, the compound may be transferred by sealed conveyor to the presses.

5.3.2 Preforming

Under normal conditions, delivery, weighing, mould-filling and pressing, should be automated in order to avoid the creation of dust. A hood connected to a bag house should enclose the press and adjacent work area. Appropriate windows and access doors should also be provided.

The moulding compound should be delivered in closed containers and stored in a glove-box style hood adjacent to the press. The weighing of the material and the filling of the moulds should be carried out inside the hood. It should also be possible to move the filled mould to the press without removing it from the hood.

In some cases, dry-pressed units are produced. The dry-blended moulded compound (chrysotile-resin-filler) is delivered in open drums to the preforming presses. It is then weighed, transferred to the mould and pressed.

5.3.3 Hot Pressing and Curing

The next step in the process is hot pressing of the preformed pieces. Usually, these pieces are moved manually from the preforming presses to the hot presses and placed into moulds. This operation can be dusty and proper precautions must be taken by the worker involved with these tasks to avoid exceeding the permissible exposure limit (PEL) If the PEL is exceeded the workers must wear an approved personal respirator and protective clothing (disposable coveralls, or coveralls that are laundered periodically).

After hot pressing and curing, the moulded pieces are removed from the mould and moved either by hand or automatically to the next process step. Although the chrysotile fibre is locked into the cured resin at this stage, workers performing these tasks may still be required to take precautions in order to maintain dust levels as low as possible.

5.3.4 Cutting, Grinding and Drilling

During these steps, the moulded pieces are cut to proper dimensions, shaped and bevelled by grinding and if necessary, fitted with holes for fastening to brake shoes. Grinding, in particular, is a very dusty procedure. These operations should be automated or semi-automated to allow a hood design to accommodate as much enclosure as possible without interfering with the operator.

If manual operations are retained, hoods must be sufficiently close to the operation so that all dust is caught. They must also be sufficiently large so that there is no interference with manual operations. It is preferred that during the actual operation, i.e. pressing, cutting, grinding or drilling, the front of the hood is closed by a transparent door. This would ensure that dust does not escape from the interior of the hood. Also, this would reduce the required bag house capacity for each of these operating stations, considerably improving the effectiveness of the dust control of the plant.

5.3.5 Finishing

This process involves polishing, painting, riveting, etc., followed by packaging. The procedures must be carefully monitored and approved personal respirators and protective clothing (disposable or washable coveralls) must be worn.

5.3.6 Wet Processes and Extrusion

The so-called wet process for friction materials is a misnomer. It refers to the use of solvents to prepare a blend of raw materials that is wet rather than dry as in the conventional method. This allows the use of binders, such as specific resins, that cannot be used otherwise. Usually, the blended compound is present in the form of dough that is dried and fluffed, to be used as other blends. Solvents are costly and they are usually not safe, both from a health or fire hazard standpoint. In addition, the fluffing operation is a dusty process and consequently, it may negate all dust control benefits that were gained initially.

There is, however, some advantage to be gained with respect to dust control if the compound is extruded to exact size requirements, followed by a combination of pressing and solvent removal. Such a process could be completely automated. Of course, the other operations that tend to generate dust, such as opening of chrysotile, cutting, grinding and drilling of the friction material, are not positively affected.

5.3.7 Impregnation

Some brake linings are produced by soaking a tape of woven chrysotile in resin, followed by curing. The chrysotile yarn used for weaving the tape contains other materials, such as brass wire, to improve the performance of the lining. The tape can be cut to appropriate length and is often used for special applications or by smaller brake repair shops that serve a large variety of cars and trucks.

Impregnation is also used for the manufacture of clutch facings, whereby chrysotile yarn is soaked in resin and wound onto a spindle prior to curing.

These installation and manufacturing methods may require cutting, grinding and drilling. Therefore, the worker involved in these activities can be exposed to dust and must take necessary precautions, such as wearing an approved personal respirator and protective clothing (disposable or washable coveralls). HEPA vacuum equipment should be used for clean-ups.

5.3.8 Waste Disposal

During the manufacture of friction materials, bag houses are used to provide exhaust ventilation and to collect dust and debris produced during grinding, etc. The solid material collected is deposited in a container located underneath the bag house. Ideally, these containers should be self-contained so that they can be removed by forklift truck and shipped to an approved disposal site for burial of the waste according to local regulations. Water can be added to these containers to suppress dust during emptying.

Alternatively, the containers used for collecting solid material should be lined with a plastic liner or bag. These bags should be sealed and transported to a suitable disposal site, where the entire bag should be buried. The collection or transport of solid waste in open bags or containers should not be permitted. The worker concerned with waste disposal activities can be exposed to dust and, therefore, must take the necessary precautions.

The objective is to recycle all waste materials into the manufacturing process.

5.4 AUTOMOTIVE BRAKE REPAIR AND INSTALLATION

Brake linings, brake pads, clutch facings, etc., consist essentially of three major components, i.e. 1) a binder (usually phenolic resin modified with additives, 2) a fibre reinforcing agent (usually chrysotile, about 50 % by weight), and, 3) a property modifier (metallic, non-metallic and carbonaceous fillers).

Small quantities of fibres may be found in the dust deposited on brake assemblies, and consist mostly of forsterite*. A result is that some fibres are present in the environment of workers engaged in repair operations. Therefore, precautions must be taken to prevent exposure of the workers to dust that may occur during automotive brake repair and installation.

The purpose of this discussion is to describe the different methods which can be used by workers to assure that their potential exposure to fibres during brake lining repair or installation is avoided, or kept to as low as level as is practicably possible. It is notable that Forsterite is the main dust component found in worn-out brake lining assemblies.

It is normal practice in automobile repair shops to start the repair process by removing the tire and wheel rim assembly from the automobile, truck, etc. In the past, the wheel and brake assembly was cleaned by using a compressed air hose and/or various types of brushes. Needless to say, this operation generates dust which is released into the workplace atmosphere. Because of the risk to workers, compressed air is prohibited (should never be used).

Several alternative methods exist. One consists of spraying the wheel/brake assembly with a fine mist of water to thoroughly soak the dust. This is followed by a stronger jet of water to wash the wetted dust off the assembly. A sufficiently large container is positioned underneath the assembly to collect the contaminated water. This water should be treated before it is discharged into the sewage system.

An ordinary garden hose can be used for this cleaning operation provided it is fitted with an adjustable nozzle that produces a fine spray as well as a concentrated jet of water. Attachments for garden hoses designed to spray insecticides or fertilizers are available for this purpose. These can be used with a non-foaming detergent (e.g. dish washer detergent) to improve the wetting of the dust.

Alternatively, it may be more convenient to use a manually pressurized spray container (or tank) such as those used for spraying garden insecticide. The nozzles for these containers usually have an excellent mechanism for the control of the water spray. Also, a non-foaming wetting agent may be added to the water in the container to assure rapid and thorough wetting of the dust.

This is one of the simplest and most efficient methods of preventing dust formation during brake repair. It requires no special equipment, and therefore, can be used practically anywhere. However, like most other manual operations, it requires a certain amount of awareness and skill.

A second method consists of a compressed air hose fitted at the end with a bottle of solvent that can be sprayed onto the brake assembly to loosen the deposited dust and to capture the resulting airborne dust in the solvent mist. The worker should begin spraying the parts that may be contaminated with the brake solvent from a sufficient distance to ensure that the dust is not dislodged by the velocity of the solvent spray. After the dust is thoroughly wetted, the spray may be brought closer to the parts to remove grease and other materials. The parts sprayed by the solvent mist are then wiped clean with a rag that must be disposed of appropriately. Rags should be placed in a labelled plastic bag or other container while they are still wet. This assures that any dust will not become airborne again after the brake and clutch parts have been cleaned. If clean-up rags are being laundered rather than disposed of, they must be washed using methods appropriate for the laundering of contaminated materials.

A variation of the compressed air/solvent mist procedure is said to have certain advantages, both in terms of cost and worker

* Forsterite: is a dehydrated magnesium silicate substance resulting from the thermal conversion of chrysotile fibres at a temperature of approximately 700 C.

protection. This variation involves the use of pressurized spray cans filled with any of several solvent cleaners commercially available from automotive supply stores. Spray cans of solvents are inexpensive, readily available, easy to use, and they save time because the air hose/mister system does not have to be assembled. Also, the spray can deliver solvents to the parts to be cleaned with considerably less force than the air hose/mister system, and will therefore produce less airborne dust.

These solvents can also be delivered from tanks that are pressurized manually.

The last, and most expensive, method uses the Enclosed Cylinder/HEPA Vacuum System. It consists of three components: 1) a drum-shaped steel cylinder with a hard plastic window, designed to cover and enclose the wheel assembly; 2) a compressed air hose and nozzle that fits through a port of the cylinder to facilitate cleaning of the brake parts inside the cylinder; and, 3) an HEPA vacuum cleaner used to evacuate airborne dust generated within the cylinder by the compressed air.

The cylinder is fitted with a pair of rubber gloves that permit the worker to reach inside the cylinder. At the rear of the cylinder, a triple pleated fabric forms a seal around the axle behind the wheel. The cylinder effectively isolates dust from the workers' breathing zone.

Cylinders can be mounted on a stand to provide convenient brake installation on vehicles on garage lifts. They come in two sizes to fit brake drums in the 18 – 30 cm (7 – 12 inch) size common to automobiles and light trucks, and 30 – 47 cm (12 – 19 inch) size range common to large commercial vehicles.

To operate the system, the brake assembly is enclosed in the cylinder after removing the tire and wheel rim assembly from the vehicle. The worker then reaches into the cylinder using the gloves and cleans the brake assembly by discharging compressed air at the brake assembly components. The worker continues to use the compressed air to keep the residual dust airborne, so that it can be removed by the HEPA vacuum cleaner. The HEPA filtered vacuum remains in operation during the entire procedure.

The brake assembly is then dismantled, repaired or replaced using tools which had previously been placed in the bottom of the cylinder. When the operation has been completed, the worker cleans all remaining exposed parts with compressed air until no visible dust remains in the cylinder. The cylinder may then be removed safely.

The HEPA filter is capable of removing all particles greater than 0.3 microns from the air. When the vacuum cleaner filter is full, it must be replaced according to the manufacturer's instructions, and appropriate HEPA dual cartridge respirators must be worn during this process. The vacuum cleaner's filter is assumed to be contaminated and should be handled carefully, wetted with a fine mist of water, placed immediately in a labelled plastic bag, and disposed of properly.

The HEPA vacuum cleaner can be disconnected from the cylinder when the cylinder is not in use. It can then be used for clutch facing work, grinding or other routine cleaning. In these cases, the material collected must be removed from the vacuum cleaner by using the plastic bag placed inside the cleaner. This bag should be placed into a labelled plastic bag or container for proper disposal at designated landfill sites.

It should be noted that many of the fibres used as substitutes for chrysotile in the manufacturing of brake linings are also considered to be potentially hazardous to health and, therefore, the same precautions must be taken when handling these materials.

5.5 MANUFACTURING OF CHRYSOTILE TEXTILE PRODUCTS FOR INDUSTRIAL USE

For the manufacture of chrysotile textiles, the longest fibre grades are used. Basically, the manufacturing process consists of:

- Opening chrysotile and blending;
- Carding to produce roving;
- Spinning roving into yarn; and,
- Weaving yarn into cloth.

Initially, different chrysotile fibre grades must be opened individually prior to blending. Up to 25 % organic carrier fibres, such as rayon and cotton, may be mixed with the chrysotile. Subsequent to blending, the normal chrysotile textile process consists of carding, spinning and weaving, which is very similar to a conventional spinning process for cotton or wool.

The heart of the chrysotile textile process is the carding operation. In this process, the opened and blended raw material is transformed into a blanket or lap by a series of needling operations which further open and intertwine the fibre. At the same time, impurities such as rock particles and short, crudy fibre bundles, as well as dust, are removed from the fibre. It is obvious that this can be a very dusty process.

The lap produced by carding is then cut into strips or rovings which are wound onto spools. These spools are then submitted to spinning operations which twist and combine the roving to form yarn. The yarn is woven into cloth on various types of looms. Roving and yarn can also be used to produce twisted and braided rope, as well as a variety of yarns, threads and cords. Yarn can also be used to produce specialty items, such as tubing.

5.5.1 Receiving and Warehousing

The same problems as previously mentioned for other manufacturing processes exist for textile production. Consequently, the same dust control measures must be applied, and the same precautions exercised by workers active in this area.

5.5.2 Debagging, Opening and Blending

The fibre preparation process begins with the debagging of chrysotile fibre (using manual or automatic procedures with the same precautions as required for other processes), followed by opening and finally, blending. (see chapters 5.1.2 and 5.1.3)

It is essential that chrysotile be properly prepared prior to the carding step. It is recognized that fibre from different sources requires different treatments. This is one of the reasons why different plants use different types of opening equipment. The sequence of the opening operation in preparing a spinning mixture will depend on the type of fibre being processed and the type of yarn to be produced. The application of the finished product must also be considered.

As for other processes, the chrysotile fibre is usually received in a semi-opened state. The purpose of the opening stage is to soften the fibre, a process necessary for the subsequent carding operation. Subsequently, the treated fibre is passed through another opening, such as a Creighton opener or willow, for further opening and fluffing.

Chrysotile blending systems can be classified into the following methods:
1) rotary mixer,
2) hopper feed blending, and automatic blending.

Automated mechanical devices, such as blending drums or single and multi-hopper blending units can be used. This equipment must be fitted with exhaust ventilation involving a bag house and a fan.

The multi-hopper automatic blending unit that employs hopper-type feeders' discharges into a weighing pan. Each single hopper weighs only one type of fibre which is dropped onto an apron to form a continuous blanket that is passed through a "picker" for further blending. The blended material is then conveyed to a collector cyclone which is used to drop the material directly into the feeding bin of the card. For small batches, single unit automatic blending machines have been designed. Fully integrated methods include a properly designed debagging station ahead of the opener and blender. This equipment is capable of weighing and discharging fibre blends to the card without generating dust.

5.5.3 Carding Operation

After opening and blending, the fibre is fed to the card for further processing. The purpose of the card is to separate fibre bundles and to align fibre to produce a uniform sheet or lap. In the process, impurities and dust are removed.

Since chrysotile yarn is spun directly from roving, uniform feed to the card is of great importance. This is accomplished by using a hopper feeder which is similar to the one used in the wool industry. The hopper may be mounted to the card or it may be mobile. In both cases, fibre is supplied to the card by batch weighing.

The card operates with three functions: working; stripping and brushing. The working action is the chief means by which the chrysotile blend is opened and turned into a uniform web. The entire sequence of action is a complicated process involving many parts of the card.

Cards continuously clean the material whereby rocks and any heavy materials fall out. Dust is drawn into the exhaust system. Undoubtedly, carding is one of the dustiest operations. Some steps towards reducing the magnitude of the problem have been made. For example, modern chrysotile cards have a totally enclosed feeding and weighing system. Impurities are removed by mote knives and grid bars underneath the cards. However, for effective dust control, the card has to be totally enclosed. In extreme cases, the condenser will have to be enclosed as well.

At the end of the carding process the web is transferred to the condenser. The function of the conveyor is to divide the uniform web into flat ribbons and to consolidate them into rovings.

5.5.4 Spinning Operation

The purpose of the spinning process is to impart a greater twist to the roving which is seldom used for itself. It is possible to insert wire or other yarn at this stage. Two types of equipment are normally used for this purpose, the ring frame and the flyer frame. In the doubler process, two or more yarns and possibly wire are combined and twisted into stronger yarn. The machines used for this process are similar to the ones used in the cotton and wool industry.

In preparation for weaving, the weft is prepared by re-spooling for the shuttle on the loom. The warp is prepared in a variety of ways. Equipment used in the wool industry is most suitable for this particular purpose.

The processes are basically dusty and hoods with exhaust ventilation must be used to maintain the dust at an acceptable level. In addition, workers must have access to clean-up equipment.

5.5.5 Weaving Operation

The equipment used for weaving chrysotile yarn in the textile industry is similar to that used in the cotton and wool industry. Two types of weaving are used in the chrysotile industry: creel and beam weaving. The former obviates the re-spooling of the weft and warp because weaving can be done directly from the spinning bobbins. Weaving can be done on a variety of machines.

It is obvious that weaving is an extremely dusty process and total enclosure by appropriate hoods with exhaust ventilation must be used. The hood configuration has to be of a suitable design otherwise it will interfere with the performance of the operator.

5.5.6 Miscellaneous Operations

Roving and yarn are used for the manufacture of twisted and braided rope, tubing, etc. These operations are performed by special machines. Although these are not as dusty as card, spinning frame or loom, general precautions and protection of the worker are still required.

5.5.7 Waste Disposal

The amount of waste material generated in a chrysotile textile plant is relatively small. It consists mainly of dust and fibre collected by the various bag houses in the plant, and waste due to cutting of yarn or cloth. These materials should be collected in plastic bags and buried in an approved disposal site. The workers performing these tasks should wear approved personal respirators and protective clothing (disposable or washable coveralls).

5.6 GASKET REMOVAL*

The following procedure* is recommended for removal of all types of fibre reinforced gasket materials. This process involves the use of a wet removal agent and a hand scraper.

1. Before breaking the flanges, position an open plastic bag underneath the flanges so the gasket and wetting agent will fall into it.

2. Wet the flanges and break the flanges apart.

3. If using a commercially available gasket removal spray solvent, follow the manufacturer's instructions. Spray the gasket and wait the recommended time, then scrape the gasket residue into the bag. Reapply the spray to keep the area wetted as necessary.

4. Although the wet solvent spray is preferable, if using water as a wetting agent, wet the gasket and begin scraping the gasket off the flanges and into the bag with a hand scraper. Reapply the wet spray as necessary.

5. After removal, wipe the flanges and tools with a rag. Dispose of rags into the bag and close.
6. After completion of flanging operations, move to the next flange, open and position bag and begin gasket removal as described above.

7. Dispose of nonfriable chrysotile contained waste according to local regulations.

All dust producing processes (such as drilling, grinding, sanding and sawing) should not be used on any gasket materials. This is particularly applicable with compressed chrysotile gasket materials as this will render the material friable.

(*Source Durabla)

6

Fibre Monitoring

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REFERENCES

INTRODUCTION

The occurrence of airborne fibrous dust in the occupational environment is well known and documented. Possible health effects are associated with the exposure to respirable fibrous dust. Airborne fibre levels need to be monitored with reliable measurement techniques such as the membrane filter method commonly used for inorganic fibres monitoring. In the membrane filter method, the sample is collected by drawing a measured volume of air through a filter. The filter is later changed from an opaque membrane into a homogeneous optical transparent specimen. The fibres are counted using a phase contrast optical microscope. Countable fibres are defined as having length (l) greater than or equal to 5µm, diameter (d) smaller than 3µm and aspect ratio (l/d) greater than or equal to 3:1.

Maximum level of protection is afforded by minimizing fibre related exposure. Maximum protection requires personal monitoring, notification of the exposed workers, adherence to practices to minimize mineral dust release, and special attention to the design of worker protection.

Key factors to be taken into consideration when developing an effective fibre monitoring program include:

- Type of dust;
- Dust regulations;
- Sampling strategy;
- Measurement technique;
- Quality assurance;
- Implementation.

6.1 OBJECTIVES

The main objective of an effective dust measurement program is to provide accurate information on airborne fibre concentrations in order to ensure the health and safety of workers. Other objectives include:

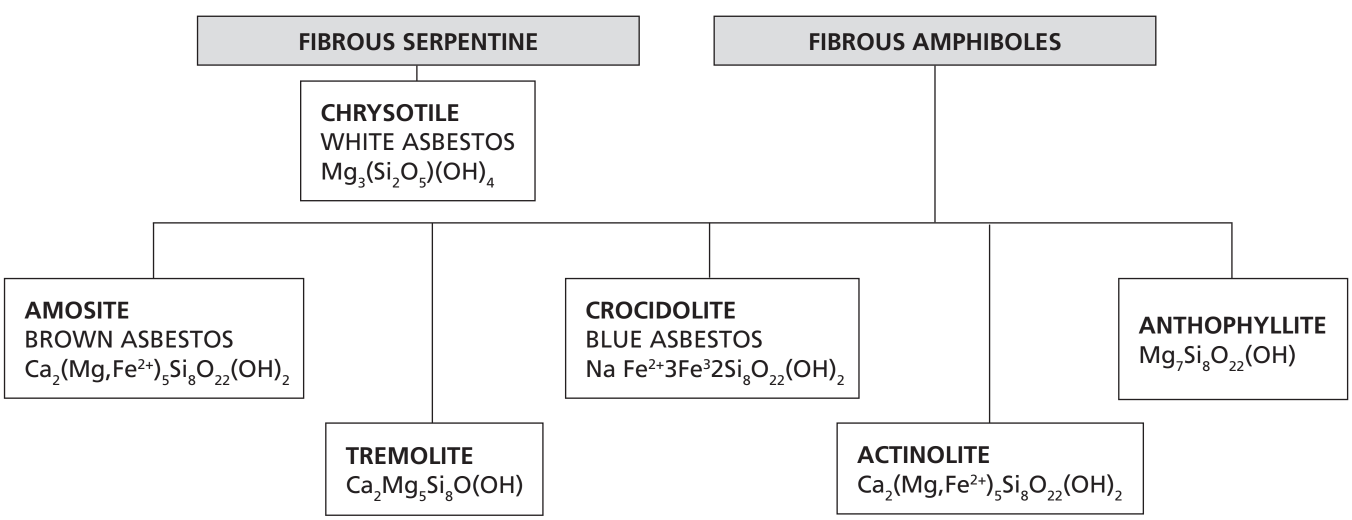
- Ensure safe working habits;
- Minimize worker exposure;
- Ascertain efficiency of engineering dust control measures;
- Check compliance with regulations;
- Assist medical surveillance of workers;
- Provide exposure measurements for health research.

6.2 DEFINITION OF ASBESTOS AND MMMF

6.2.1 Asbestos, Chrysotile and Amphiboles

The term “asbestos” is used for certain hydrated silicates when these silicates crystallize into the asbestiform variety. There are six recognized varieties of asbestos: One fibrous serpentine - chrysotile; and, the most common fibrous amphiboles - amosite, anthophyllite, crocidolite, tremolite and actinolite (**Figure 1**).

FIGURE 1 - ASBESTOS MINERALS AND FORMULAS



6.2.2 Man Made Mineral Fibres (MMMF)

Man-made mineral fibres include several types of fibres and can be classified as mainly:

- Rock wool/slag wool;
- Glass wool;
- Glass fibre;
- Refractory fibres (ceramic...);
- Carbon fibre;
- Modified, inorganic fibres;
- Synthetic organic fibres;
- Others.

(see also Section 3, **APPENDIX 1, ANNEX III**)

From the epidemiological and animal studies, the most important factors for the biological activity of a fibre are:

- Respirability, as defined by the dimensions and the density of the fibres;
- Dose, or dose-response; and
- Durability in the biological system (biopresistence).

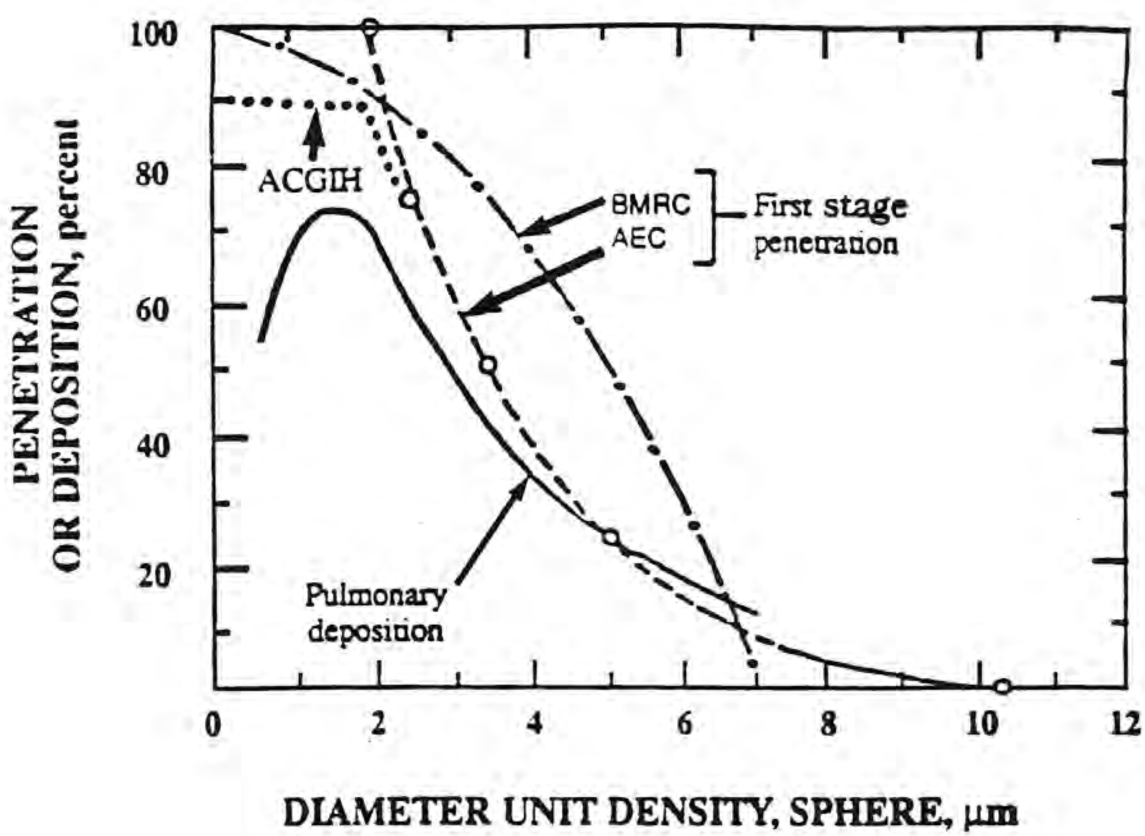
Other factors, such as the surface chemistry, the susceptibility of workers, etc., are also important.

Phase contrast microscopy counting rules include respirable fibres of at least 5 micrometers in length. That will constitute an index of exposure that should never be exceeded over a certain period of time.

6.3 RESPIRABLE DUST

Roughly speaking, respirable dust includes those unit density particles with a diameter less than 7 micrometers (μm) according to the criteria of the British Medical Research Council (BMRC) or a diameter less than 10 μm according to the criteria of the United States Atomic Energy Commission (AEC) or the American Conference of Governmental Industrial Hygienists (ACGIH) (**Figure 2**). Fibres and dust particles satisfying these criteria are capable of reaching and being deposited in the nonciliated portion of the lung where gas-exchange takes place.

FIGURE 2 - RESPIRABLE DUST



Source: Occupational Exposure Limits for Airborne Toxic Substances. Occupational Safety and Health, Series No. 37(1980). ILO, Geneva

6.4 SOME FIBRE REGULATIONS

6.4.1 Asbestos

World Health Organization, Oxford, U.K. 1989, Occupational Exposure Limit for Asbestos
Recommendations made by a Group of Experts, brought together by the WHO in 1989, concluded that no employee should be exposed to a concentration of airborne chrysotile asbestos greater than 1 fibre/ml.

In the United States, the threshold limit values are time-weighted-average concentrations measured over an eight-hour work shift and 30 minutes short term exposure:

SOURCE	8 HR - TWA (PEL) (FIBRES >5 μ/ml)	30 MIN - STEL (FIBRES >5 μ/ml)
OSHA (Current)	0.1 All asbestos types	0.1 (All forms)
ACGIH	0.1 All asbestos types	

In Quebec, the occupational limit is 1.0 f/ml. (Regulations are addressed in Section 3 of the manual).

6.4.2 Man Made Mineral Fibres (MMMF)

Most countries have gravimetric regulations:

- Total dust: 2 to 10 mg/m^3
  and/or
- Respirable dust: 1 to 5 mg/m^3

However, there is a trend to have fibre number exposure limit standards for MMMFS. Existing and proposed standards in different countries range from 0.1 f/cc to 2 f/cc.

6.5 EFFECTIVE FIBRE MONITORING PROGRAMS

The three main requirements to have an effective fibre monitoring program are:

- Commitment of management;
- Monitoring strategy;
- Sound measurement methods.

6.6 COMMITMENT OF MANAGEMENT

As part of the management process, managers of every company should be concerned with the proper monitoring of employee exposure to airborne fibre. The measurement of airborne fibre in workplace is crucial:

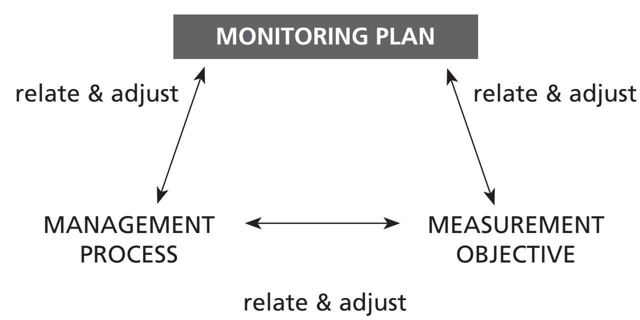
- To preserve the health and safety of workers;
- To comply with regulations;
- To improve the working conditions of employees;
- To promote good relationship and better productivity of their employees;
- To ensure the survival of their company and industry.

6.7 MONITORING STRATEGY

The development and adoption of an effective monitoring plan is essential. Responsibilities should be identified to gain the effective implementation of monitoring programs for chrysotile and man-made mineral fibres in the concerned industries.

An analytical framework was developed by the Canadian Environmental Assessment Research Council (1987) for evaluating the rationale, requirements and responsibilities for pre-and post-decision monitoring programs. The following adapted framework assumes that effective monitoring consists of three elements:

- Monitoring plan;
- Management process;
- Measurement objective.



THE MONITORING TRIAD

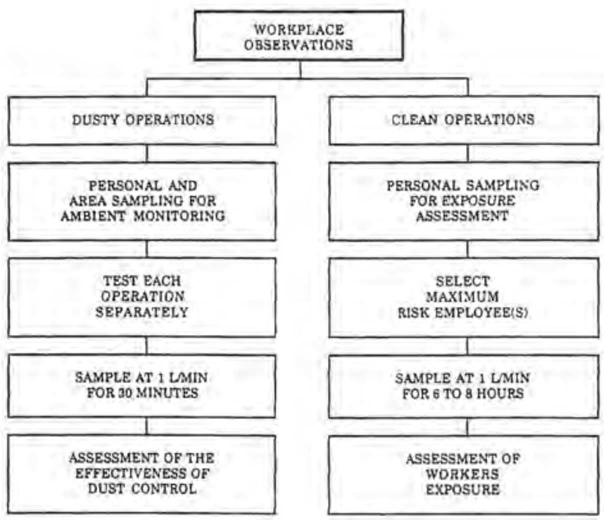
This monitoring triad is in a continual process of readjustment to maintain maximum fit or congruence in a complex and uncertain situation. Experience has shown that no monitoring program is embedded in a static situation. All have elements of the unexpected; hence, the need for flexibility. Depending upon their level of congruence, these three factors can reinforce one another, or work against each other to inhibit effectiveness.

There is no such thing as one "best" strategy for all situations. However, some strategies are clearly better than others for particular situations. Guidelines are provided for comparing alternative strategies. The following are broad considerations:

- Availability and cost of sampling equipment (pumps, filter, direct reading meters, etc.);
- Availability and cost of sample analytical facilities;

- Availability and cost of personnel to take samples;
- Location of employees and work operations;
- Occupational exposure variation (intraday and inter-day);
- Precision and accuracy of sampling and analytical methods; and
- Number of samples needed to obtain the required accuracy of the exposure measurement.

This generalized flowchart of the measurement strategy is suggested to determine the effectiveness of dust control and to assess exposure of workers.



A more detailed flow-chart diagram is shown for individual exposure assessment in the Recommended technical Method No. 1A (RTM1A) of the Asbestos International Association (1987).

6.8 SOUND MEASUREMENT METHODS

6.8.1 Fibre Counting Methods Introduction

A variety of sampling and analytical techniques have been used to quantify and/or identify fibrous dust. These include optical and electron microscopy, X-ray diffraction, infrared spectroscopy, differential thermal analysis and light scattering diffraction patterns resulting when light is passed through a fibrous particle dust cloud aligned by passing through a high-intensity electric field (see **Table 1**).

The quantification of fibrous dusts in occupational and environmental air samples is difficult for several reasons:

- The mass of fibrous dusts present in air is relatively low even though the fibre number concentrations may be high.
- Many instrumental analytical techniques cannot differentiate the fibrous-shape of particles from their non-fibrous mineralogical polymorphs. (e.g. The chemistry of a chrysotile fibre can be the same as that of a non-asbestiform serpentine flake particle.).
- The identification of some fibrous dust types requires expensive instrumentation and analytical methodology such as electron microscopy, electron diffraction and micro-chemical analyses.

The recommended technique, by phase-contrast microscopy (membrane filter method) for the determination of airborne fibre number concentrations is the method of the World Health Organisation (WHO) presented in 1997. It is quite similar with the method mentioned below.

The second technique widely used is the one based on the Asbestos International Association/RTM 1 (1982), which was adopted by the International Labour Office (ILO, 1984). For most inorganic materials with refractive indices greater than 1.51, the following methods can be used:

- Reference method for the determination of airborne asbestos fibre concentrations at workplaces by light microscopy (Membrane filter method). RTM 1, AIA (1982).
- Reference methods for measuring airborne man-made mineral fibre. WHO/EURO (1985).
- Determination of the number concentration of airborne inorganic fibres by phase contrast optical microscopy. Membrane filter method. ISO 8672 (1993).
- NIOSH Method 7400. Revision #3 (1989).
- Determination of airborne fibre number concentrations. A recommended method, by phase-contrast optical microscopy (membrane filter method). WHO (1997).

Samples collection and record

Prior to and after any sampling day, the sampling pump calibration (**APPENDIX 1**) shall be checked.

To meet the objective of the occupational exposure measurements, the appropriate sampling strategy will be of prime importance.

Different sampling schemes are available:

Long term:
- Full-shift consecutive samples
- Partial-shift consecutive samples

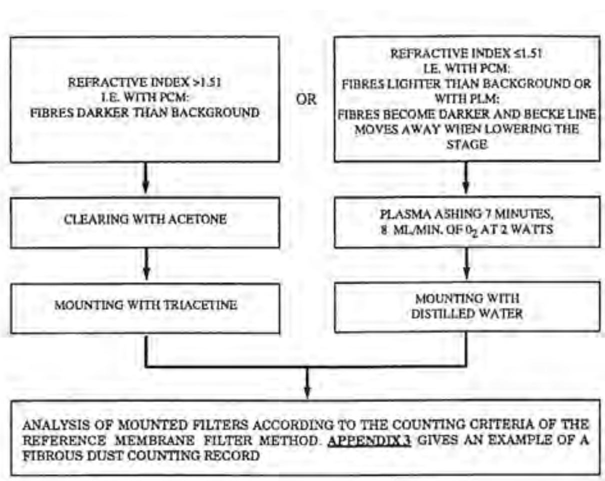
Short term:
- Random samples
- Systematic samples

The filter size, flow rate and sampling time are the three parameters which should be used to have acceptable fibre loadings on filters. Taking into account filter loading considerations, sampling duration time for each sample will be determined.

With the sampling details, all data necessary for the determination of the fibre concentration must be recorded. **APPENDIX 2-3** gives an example of a dust sampling record.

Preparation and analysis

We must first classify the fibres according to their refractive index and then select the right mounting technique to ensure a proper analysis.



Sampling can be easily learned and accomplished but the counting of fibres using the membrane filter method can only be performed by well trained counters with a rigorous quality control program.

Quality assurance of fibre counts

The quality control program should contain at least the following elements:
- Laboratory blanks (4% of the filters).
- Field blanks (at least 2 or 10%).
- Reference samples (one every counting day).
- Blind filters (10% of the samples).
- Check samples (e.g. specific field training slides, sample of known concentration from experienced counters).
- Inter-laboratory exchanges (NIOSH, AFRICA ...).

All laboratories engaged in fibre counting should participate in a proficiency testing program to ensure good reproducibility.

- NIOSH - Proficiency Analytical Testing (PAT).

For information on the PAT Program, contact:
NIOSH
Proficiency Analytical Testing (PAT). Program R-8
4676 Columbia Parkway
Cincinnati (OH) 45226, USA

- IOM - Asbestos Fibre Regular Informal Counting Arrangement (A.F.R.I.C.A.).

For information on the A.F.R.I.C.A. exchange, contact:
Institute of Occupational Medicine
8 Roxburgh Place
Edinburgh, EH8 9SU, U.K.

- IRSST - Contrôle de qualité de la numération de fibres.

For information, contact:
Institut de recherche Robert-Sauvé en santé et en sécurité du travail
505, Boul. De Maisonneuve Ouest
Montréal (Québec) H3A 3C2

- Any other recognized inter-laboratory exchanges.

6.8.2 Gravimetric methods

The workplace gravimetric measurement methods of total or respirable airborne dust are often used to supplement or to replace the fibre count membrane filter method. Gravimetric results can be found by:

- Weighing the dust collected on the filter.
- Quantifying the filter using infra-red spectroscopy:
  - KBr after low-temperature ashing of the filter or
  - Total internal reflection phenomenon.
- Direct-reading instruments:
  - using light scattering
  - beta-radiation or
  - piezo-balance or
  - any other recognized quantification techniques.

6.9 OTHER NATURAL AND MAN-MADE FIBRES

6.9.1 Gravimetric Methods

At present, in most countries, standards for most natural and man-made fibres are based on gravimetric methods (mg/m^3). As reported by Krantz et al. (1987) the most frequently used way of regulating a dust level is by introducing a limit value for total dust, very often combined with a limit value for respirable dust, as measured by customary gravimetric methods. Accurate measurement methods for such determinations can be found in the Manual of Analytical Methods produced by the National Institute of Occupational Safety and Health, NIOSH (1984) for the measurement of nuisance dust.

- Nuisance Dust, Total.
  NIOSH Method 0500. Issued 2/15/84.

- Nuisance Dust, Respirable.
  NIOSH Method 0600. Issued 2/15/84.

6.9.2 Fibre Counting Methods

Some countries have already introduced regulations with fibre number concentrations which apply to some natural and man-made fibre (MMF). For the determination of airborne concentrations in the workplace, the most widely recommended membrane filter methods are:

- "Reference Methods for Measuring Airborne Man-Made Mineral Fibres", prepared by the World Health Organization / Europe, WHO/EURO (1985).

- Determination of the Number Concentration of Airborne Inorganic Fibres by Phase Contrast Microscopy "Membrane Filter Method" a third draft international standard of the International Standard Organization, ISO (1993).

6.9.3 Special Considerations for Airborne Man Made Mineral

Fibres

6.9.3.1 Size distribution

To assess the size distribution of the airborne man made mineral fibres (MMMF) in the workplace, the WHO/EURO (1985) developed a Scanning Electron Microscope (SEM) method:

"Reference Method Using a Scanning Electron Microscope to Determine Size of Airborne MMMF in the Workplace"

6.9.3.2 Fibre identification

With increasing use of MMMF, many situations are developing where workers may be exposed to more than one variety of fibre, either man-made or natural. In such circumstances, it is important to be able to characterize the fibre types present. The use of the analytical transmission electron microscopy technique is available for airborne fibre identification but it is a tool which needs an extensive expertise and is too costly to be used on a routine basis. For the characterization of fibre in ambient air, a scanning electron microscopy method has been developed: "Determination of numerical concentration of inorganic fibrous particles – Scanning electron microscopy method", International Standard Organization, ISO 14966 (2007).

For the identification of fibre types, it is sometimes convenient to characterize bulk or settled dust in the workplace even though the components of the settled dust may quantitatively differ from those of the airborne dust. The cheapest technique to identify fibrous mineral dust in settled dust is using the polarized light microscope. Analytical transmission electron microscopy is recommended when the particles are smaller than 1.0 µm.

6.10 ENVIRONMENTAL MONITORING

6.10.1 Introduction

Two categories of emission sources into the environment are generally generated from the industrial activities.

- Open source emissions;
- Point source emissions.

The open source emissions are generally less accurately measured with existing techniques than the point source emissions which can be monitored with relatively accurate measurement methods.

6.10.2 Regulations

Asbestos emission standards are from no visible emissions to the outside air in the United States to 2 fibres per cubic centimetre of the gases in Canada and in the European Economic Communities where for the latter, the emission standard can also be of 0.1 mg/m^3.

6.10.3 Open Source Sampling

The three well known techniques of measurement of open source emissions were described by Kolnsberg (1976):

- Quasi-stack sampling technique;
- Roof monitor sampling technique;
- Upwind-downwind sampling technique.

The upwind-downwind sampling technique is universally used to measure the fugitive dust, but it is the least reliable of the three techniques, being affected by so many variables including weather conditions, the wind speed and direction, the precipitation, the soil type, the vegetation cover, the surface moisture and the traffic activity as discussed by Jutze and Axetell (1976).

6.10.4 Point Source Sampling

For point source sampling, there exist conventional and well established methods which rely on manual techniques such as stack sampling, aimed at collecting samples by filtration to measure the mass and fibre concentration of particulate emissions.

6.10.5 Sample Evaluation

The commonly used methods of evaluation can be briefly classified:

- Mass determination method;
- Fibre counting method.

The mass determination is simpler to carry out with good accuracy. However the fibre counting method provides specific information on the fibre count which is usually preferred for correlation with health risks.

6.10.6 Recommendations

A complete program for the environmental surveillance of industrial activities will include the surveillance of diffused and point source emissions to monitor fibre concentrations in ambient air outside factories and air surrounding communities (e.g. the general environment).

A more practical approach will emphasize the monitoring of the point source emissions which are usually the most important sources of dust (usually more than 80% of all dust emissions). By monitoring the point source emissions, we are monitoring the performance of the industrial ventilation system, which if working properly, will limit the amount of fibre emitted into the environment.

A good monitoring program of point source emissions will usually lessen, if not eliminate, the need for costly and inaccurate surveys of airborne concentrations of fibres in the ambient air outside factories and surrounding communities.

6.11 SUMMARY AND IMPLEMENTATION

6.11.1 Equipment

A list of suitable equipments for the membrane filter method with suppliers is given in **APPENDIX 4**.

6.11.2 Training

The person assigned to the fibre monitoring should receive adequate training to ensure the proper use of the reference methods for the determination of airborne fibre concentrations.

6.11.3 Overview of the Membrane Filter Method

To collect a sample, a volume of air is drawn through a membrane filter. The filter is later changed from an opaque membrane into a homogeneous optically transparent specimen. The fibres are then sized and counted using a phase contrast optical microscope. The result is expressed as fibres per ml of air, calculated from the number of fibres on the filter and the measured volume of air sampled.

6.11.4 Quality Control

Optically-visible fibre concentrations can only be defined in terms of the results obtained with a given measurement method. Uniformity of results between laboratories can only be ensured by a satisfactory quality control program. Because the membrane filter method is operator dependent, it is essential to ensure that the results are comparable between laboratories to ensure that details of the method are applied completely as specified.

Variations in method are therefore permitted, provided it is demonstrated that these have no significant effect on the results obtained. The quality control assurance is regarded as being part of the membrane filter method.

6.11.5 Record Keeping

The guidelines listed in the booklet "Safety in the Use of Asbestos", by ILO (1984) should be followed:

Records should be kept by the employer on all aspects of dust exposure. Such records should be clearly marked by date, work area and plant location.

Records regarding all aspects of dust exposure should be maintained, as far as it is practicable, for at least a 40-year period following termination of employment. Records dealing with dust sources, product composition and content, and environmental concentrations in the workplace, may be reduced to micro-film for storage.

6.11.6 Conclusion

The measurement of airborne fibre in workplace is crucial to:

- preserve the health and safety of workers;
- comply with regulations;
- improve the working conditions of employees.

They constitute the three main measurement objectives of a good monitoring plan that need to be endorsed by the managers of every industry as part of any management process.

REFERENCES

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2. **KOLNSBERG, H.J.** (1976). A Guideline for the Measurement of Air-borne Fugitive Emissions from Industrial Sources. Symposium on Fugitive Emissions: Measurement and Control, Hartford, CT, May 1976, EPA/600/2-76-246, pp. 33-49.

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10. **NIOSH** Method 7400 (1989). Final Copy of the Revised NIOSH Fiber Count Method. National Institute for Occupational Safety and Health. Revision #3, Issued on 05/15/89.

11. **INTERNATIONAL STANDARD ORGANIZATION** (1993). Air Quality – Determination of the Number Concentration of Airborne Inorganic Fibres by Phase Contrast Optical Microscopy. Membrane Filter Method. ISO 8672.

12. **WORLD HEALTH ORGANIZATION (WHO)** (1997). A recommended method by phase-contrast optical microscopy (membrane filter method).

13. **INTERNATIONAL STANDARD ORGANIZATION** (2006). Microbeam Analysis – Electron Probe Analysis. Quantitative Point Analysis for Bulk Specimens using Wavelength-dispersive X-Ray Spectroscopy. ISO 22489.

14. **INTERNATIONAL STANDARD ORGANIZATION** (2007). Ambient Air – Determination of Numerical Concentration of Inorganic Fibrous Particles – Scanning Electron Microscopy Method. ISO 14966.

TABLE 1 -MEASUREMENT METHODS FOR THE EVALUATION OF FIBROUS DUST

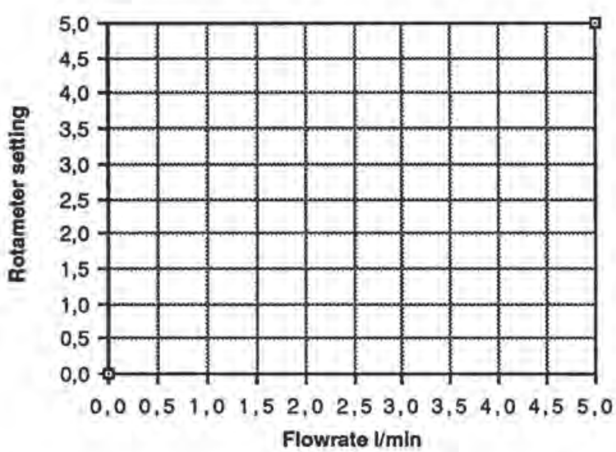
METHOD	ANALYTICAL MEAN	FEATURE EVALUATED
1. Fibre Count	1.1 Phase contrast light microscopy	Morphology
	1.2 Scanning electron microscope / energy dispersive analysis	Morphology & elemental analysis
	1.3 Transmission electron microscope/ Energy dispersive analysis	Morphology & elemental analysis
	1.4 Light scattering (FAM)	Morphology
2. Mass Concentration	2.1 Weighing	Mass
	2.2 Light scattering	Mass
	2.3 Beta-radiation	Mass
	2.4 Infrared spectroscopy	Mass
	2.5 Differential thermal analysis	Mass
3. Identification	3.1 Polarized-light microscope	Morphology & refractive index
	3.2 X-Ray diffraction	Crystallographic parameters
	3.3 Electron microscope with microprobe	Morphology & elemental analysis

APPENDIX 1 SAMPLING PUMP CALIBRATION

Project no.:
Equipment I.D.:
Date:

Temperature: °C
Barometric pressure: mm Hg
R.H.: %

Rotameter setting	Volume of burette (liter)	Pressure (in. H_2O)	Time (sec)				Flowrate l/min
			Tr. 1	Tr. 2	Tr. 3	Average	



CALIBRATION CHECK

Location:
Project:
Date:
By:

Max. rot. setting	Pressure, in. H_2O	Time, sec.
	Average:	

	before	after
Hour:		
Temperature (°C):		
R.H. (%):		
Bar. p. (mm Hg):		
Rot. setting:		
Vol. bur. (liter):		
Time (sec):		
Flowrate (l/min):		

COMMENTS: ______________________
____
____

SIGNATURE: ______________________

AI-RC-01

APPENDIX 2 DUST SAMPLING RECORD

Date:	Sample ID:
Facility:	Area:
Address:	Project No.

Temperature:	R.H.	Atmospheric pressure:

Filter lot no.	Airborne substance measured:
Employee Name/No.:	Sampled by:

Protective equipment (cap. ear, eye, respirator, ..)
Operation (s) monitored:

Type of sample:	Personal:	Other	Shift duration:

Details of operation (machine type, material code, ..)
Control measures (natural, local,..)
Cleaning (vacuum, wet..)

Pump ID.	Rotameter reading	Flow rate (LPM)
Calibration location	By:	Date

Sampling/analytical method
Observations
Photo No.
Type of test (workplace, clearance, ..)

Test No.	Time Start	Time End	Elapsed Time	Volume (L)	Analysis no.	Fibres/cc

AVERAGE VALUE:__________

Remarks, possible interferences, action required:

APPENDIX 3 FIBROUS DUST COUNTING RECORD

COMPANY: ____________________

COUNTED BY: ____________________

COUNTING RULES: ____________________

MICROSCOPE:

Objective N.A.: __________

Filter: __________

SIGNATURE:

____

PAGE: ____________________

DATE: ____________________

PROJECT NO: ____________________

Magnification: ____________________

Field area (mm^2): ____________________

Limit of detection with Mark II

BLOCK NO: ______ , ______ µm visible

BLOCK NO: ______ , ______ µm invisible

Filter no						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
TOTAL						
Fibers (f)						
Fields						
f/field						
f/mm²						
f/cc						

APPENDIX 4 LIST OF EQUIPMENT AND LIST OF SOME SUPPLIERS FOR MEASURING FIBROUS DUST USING THE MEMBRANE FILTER METHOD

EQUIPMENT	SUPPLIERS
1. Personal Sampling Pump	SKC Inc. 863 Valley View Road Eighty Four, PA 15330 U.S.A. Zefon International Inc. 5350 SW 1st Lane Ocala, FL 34474 U.S.A. Gilian Instrument Corp. 35 Fairfield Place W. Coldwell, N.J. 07006 MSA Corporate P.O. Box 426 Pittsburgh, PA 15230 U.S.A.
2. Filter	Millipore Corporation 290 Concord Road Billerica, MA 01821 U.S.A. Sartorius Mechatronic Canada Inc. 2179 Dunwin Drive Units 4 & 5 Mississauga, Ontario Canada L5L 1X2 Pall Corporation 2200 Northern Boulevard East Hills, NY 11548-1289 U.S.A.

APPENDIX 4 LIST OF EQUIPMENT AND LIST OF SOME SUPPLIERS FOR MEASURING FIBROUS DUST USING THE MEMBRANE FILTER METHOD

3. Holder and Cowl	Pall Corporation 2200 Northern Boulevard East Hills, NY 11548-1289 U.S.A. Millipore Corporate 290 Concord Road Billerica, MA 01821 U.S.A.
4. Film Flow Meter	SKC Inc. 863 Valley View Road Eighty Four, PA 15330 U.S.A. MSA Corporate P.O. Box 426 Pittsburgh, PA 15230 U.S.A. Zefon International Inc. 5350 SW 1st Lane Ocala, FL 34474 U.S.A.
5. Optical Microscope (Phase Contrast)	McCrone Microscopes & Accessories 850, Pasquinelli Drive Wesmont, Illinois 60559 U.S.A. Mel Sobel Microscopes Ltd. 29 Louis Street Hicksville, NY 11801 U.S.A. Leica Microsystems (Canada) Inc. 111 Granton Drive Suite 400 Richmond Hill, ON Canada L4B 1L5

APPENDIX 4 LIST OF EQUIPMENT AND LIST OF SOME SUPPLIERS FOR MEASURING FIBROUS DUST USING THE MEMBRANE FILTER METHOD

6. Eyepiece Graticule	McCrone Microscopes & Accessories 850, Pasquinelli Drive Wesmont, Illinois 60559 U.S.A. SPI Supplies / Canada Box 187, Postal Station "T" Toronto, ON Canada M6B 4A1
7. Stage Micrometer	McCrone Microscopes & Accessories 850, Pasquinelli Drive Wesmont, Illinois 60559 U.S.A. SPI Supplies / Canada Box 187, Postal Station "T" Toronto, ON Canada M6B 4A1
8. Test Slide	Zefon International Inc. 5350 SW 1st Lane Ocala, FL 34474 U.S.A.

(*) These lists are only indicative and other suppliers may be identified. Purchasers should check that the equipment does meet the requirements.

7

Personal Protective Equipment

7. Personal Protective Equipment

PART I - RESPIRATORY PROTECTION PROGRAM (RPP)

PART I - RESPIRATORY PROTECTION PROGRAM (RPP)

INTRODUCTION

This section covers the requirements for the proper selection, use and care of respiratory protective devices and for the administration of an effective respiratory protection program.

Respiratory protection must be used only as a temporary measure and should not be adopted as a substitute for engineering controls or other corrective technical measures.

7.1 RESPONSIBILITIES

7.1.1 Employer Responsibilities

a) The employer must be responsible for the preparation and implementation of written operative procedures for a Respiratory Protective Program (RPP), as outlined in 7.2;
b) The employer must designate one person to administer the said program;
c) The employer must provide sufficient quantities of suitable respiratory protection equipment. This equipment shall be provided to all employees involved in any given situation where the level of airborne chrysotile dust exceeds or could exceed the permissible exposure limit;
d) The employer must inform all employees when the concentration of airborne fibre levels reaches their permissible exposure limit;
e) The RPP must be provided and maintained by the company, with no cost to the employees;
f) The employer must, with the assistance of the Safety and Health Department, maintain a list identifying the various work areas and activities with their corresponding personal protective measures. This list must be updated at least every year or when necessary.

7.1.2 Employee Responsibilities

a) The person who has been provided with a respirator shall use and care for it in accordance with the instructions and training received;
b) When employees are notified that airborne concentrations have reached the permissible exposure limit, they should use the protective devices provided and ensure key factors for fit testing are followed;
c) The employee must take all precautions to prevent damage to the respirator provided for his/her use and must report any malfunction or damage to the respirator to his/her immediate supervisor.

7.2 PROGRAM CONTENT

A Respiratory Protection Program (RPP) shall consist of the following components:

- Program administration (see 7.3);
- Chrysotile dust level evaluation (see 7.4);
- Selection of appropriate respirator (see 7.5);
- Respirator facial fit (see 7.6);
- Training (see 7.7);
- Use, inspection and monitoring of respirators (see 7.8);
- Cleaning, inspection, maintenance and storage of respirators (see 7.9);
- Health surveillance of respirator wearers (see 7.10);
- Program evaluation (see 7.11).

7.3 PROGRAM ADMINISTRATION

1. The Program Administrator shall administer the RPP;
2. He/she shall evaluate the effectiveness of the RPP;
3. Where necessary to the proper functioning of the RPP, the program administrator must consult with users, manufacturers and other people knowledgeable in occupational hygiene and health, safety and industrial processes;
4. The program administrator must ensure that all persons required to wear respirators receive appropriate written instructions.

7.4 EVALUATION OF CHRYSOTILE DUST LEVEL

7.4.1. Dust Level Monitoring

Chrysotile dust levels in the workplace must be monitored by following a survey strategy. The results should be distributed to the persons sampled, the supervisor and the union representative. The results will determine whether or not a respirator is required, and if so, what type.

7.4.2 World Health Organization, Oxford, UK 1989 Occupational Exposure Limit for Asbestos

Recommendations made by a Group of Experts, brought together by the WHO in 1989, concluded that no employee should be exposed to a concentration of airborne chrysotile asbestos greater than 1 fiber/ml.

7.5 SELECTION OF THE APPROPRIATE RESPIRATORY EQUIPMENT (based on Quebec regulations for chrysotile)

Table 1 summarizes assigned protection factors for respiratory protection.
Tables 2 and 3 specifically relates to some of the respirator models recommended for chrysotile use.

7.5.1 Work areas and activities where fibre concentrations ≤ 1.0 f/cc

At 1.0 f/cc or below, the use of respirators is not required. However, if a worker requests respiratory protective equipment, a maintenance free, reusable half face respirator should be provided in accordance with European Standard EN 149 Category FFPS2 **(Figures 1A, 1B and Table 2)**.

Note: Québec regulation (RSST, Section 42) states: in Québec, exposure to a known or suspected carcinogen, exposure should be reduced to a minimum; even if it remains within the standards provided.

7.5.2 Work areas where fibre concentrations are > 1.0 and ≤ 10.0 f/cc

In those areas or activities where the average concentration of chrysotile fibre is greater than 1 and at 10 f/cc or below, respiratory equipment as a maintenance free, reusable half mask respirator or a half mask respirator equipped with class 100 HEPA (High Efficiency Particulate Air) filters must be worn. This equipment should be used only when necessary corrective technical measures are being taken or when the latter prove insufficient. It should also be used for maintenance work where dust concentration levels up to 10 f/cc are possible **(Figures 1C, 1D, 2A, 2B and Table 2).**

NOTE: Effective January 1 1995, under Quebec regulations, workers can wear a maintenance-free, reusable, half face piece respirator in work areas where the concentrations of chrysotile fibre does not exceed 5 f/cc. Such respirators must meet European Standard EN149 Category FFP2. In Europe, such respirators are permitted for exposures up to 12 times the occupational exposure limit **(Figures 1A, 1B and Table 2).**

TABLE 1 ASSIGNED PROTECTION FACTORS (CSA STANDARD Z94.4-93)

Type of Respirator	Type of Facepiece			
	Quarter	Half	Full	
Air- purifying	5	10	100	
Atmosphere-supplying				
SCBA (demand)*	-	10	100	
Airline (demand)	-	10	100	
	Respiratory Inlet Covering			
	Half Mask	Full Face	Helmet Hood	Loose Fitting Facepiece
Powered air-purifying (HEPA)	50	1000 £	1000 £	25
Atmosphere-supplying				
Airline-pressure demand	50	1000	-	-
Continuous flow	50	1000	1000	25
SCBA (positive-pressure or open/closed circuit)	-	££	-	-

* SCBA of the demand-type shall not be used in IDLH situation.
£ Assigned Protection Factors (APF) that are listed in this table are for respirators used with high-efficiency particule-air filters (HEPA), combination HEPA and sorbent cartridges, and canisters. Protection factors of 100 are to be assigned using dust, mist, or fume filters (DMF).
££ Positive-pressure SCBA are presently regarded as providing the highest degree of protection. Limited recent simulated workplace studies have concluded that all users may not be able to achieve protection factors of 10 000. Therefore, based upon this limited data, a definitive APF of no greater than 10 000 should be used.

NOTES:
1. APF are not applicable for escape-type respirators.
2. Combination respirators such as airline respirators equipped with an air-purifying filter should have the APF assigned on the basis of the mode of operation. For example, if the combination respirator is to be used on both the airline mode as well as the air-purifying mode, then the APF applicable to that respirator in the air-purifying mode applies.
3. The maximum concentration against which an air-purifying respirator will protect is determined by the design efficiency and capacity of the cartridge, canister, or filter and the facepiece-to-face seal on the user. For gases and vapours, the maximum concentration for which the air-purifying respirator is designed to be used in the appropriate assigned protection factor multiplied by the exposure limit (EL). However, air-purifying respirators are not to be used for entry into concentrations of contaminants which are at or above IDLH.
4. The above APF values are similar to values proposed in a new edition of ANSI Standard Z88.2 currently in preparation.

TABLE 2 RESPIRATOR SELECTION TABLE FOR CHRYSOTILE DUST (based on manufacturers recommendations)

Respirator Type	Protection	Example	Use Concentrations (Quebec Regulations)	Protection Factor
Maintenance-Free particulate respirator	FFP2	3M 9320 / 3M 9322 North 910FFP2NR	< 5 fibers/cc	5
Maintenance-Free particulate respirator	N100 P100	3M 8233 / 3M 8293 North 8150P100	< 10 fibers/cc	10
Half-face negative pressure	P100	3M 6000/7500 + 3M 2091/2291/7093 North 7700 / 5500 series	< 10 fibers/cc	10
Full-face negative pressure	P100	3M 6000/7800S/FF-400 + 3M 2091/2291/7093 North 7600 / 5400 series	< 100 fibers/cc	100
Loose- fitting PAPR	HEPA	3M Airstream / 3M Breathe-Easy / 3M GVP (3M L-701) North Primair series	< 25 fibers/cc	25
Tight- fitting PAPR or Helmet	HEPA	3M Powerflow / 3M Breathe-Easy (6800) 3M GVP (L-901/6800) North 7800 / 7600 / 5400 series	< 1000 fibers/cc	1000
Supplied Air (Continuous flow)				
Half-face positive pressure	Supplied air	3M 6200 + dual air-line North PA 101 / 7000 / 5400 series With CF 2000 attachment	< 50 fibers/cc	50
Full-face positive pressure or Helmet	Supplied air	3M 6800 + + dual air-line / 3M L-901 North PA 111, 121 With CF 2000 attachment North 7600 / 5400 series	< 1000 fibers/cc	1000

TABLE 3 RESPIRATOR SELECTION TABLE FOR CHRYSOTILE IN UNITED STATES

42CFR 84	Aerosol test		
Minimum Efficiency	Non-aerosols	Included oil aerosols*	Included oil aerosols
99.97%	N100	R100	P100

FIGURE 1A NORTH 910FFP2NR

FIGURE 1B 3M FOLDABLE RESPIRATOR, MODEL FFP2


3M™ 9320 Foldable Respirator - FFP2

- Three-panel design for improved comfort, fit and communication
- Reliable, effective protection agaist fine particulates
- Individually packed, foldable design prevent contamination before use and allows easy storage
- Soft inner cover-web for greater comfort against the skin
- Even-tensioned straps relieve pressure for a comfortable and secure fit
- Blue colour coded straps denoting FFP2 protection level.
- Standard: EN149:2001 FFP2
- Approval: CE Marked
- Maximum use level: Assigned Protection Factor: 10 x WEL (Nominal Protection Factor 12 x WEL)

3M 9320

3M™ 9322 Foldable Respirator (Valved) - FFP2

- Same as 3M 9320 plus
- 3M™ Cool Flow valve reduces heat build-up to offer comfortable protection, particularly in hot and humid conditions

3M 9322

FIGURE 1C NORTH MAINTENANCE FREE MODEL 8150P

FIGURE 1D 3M MAINTENANCE FREE RESPIRATORS, 100% EFFICIENT

- **3M™ 8233 N100 Particulate Respirator**
  - NIOSH approved N100 particulate respirator, TC-84A-1298
  - At least 99.97% filtration efficiency against solid and liquid aerosols that do not contain oil.
- **3M ™ 8293: P100 Particulate Respirator**
  - NIOSH approved P100 particulate respirator, TC-84-2561
  - At least 99.97% filtration efficiency against solid and liquid aerosols including oils.

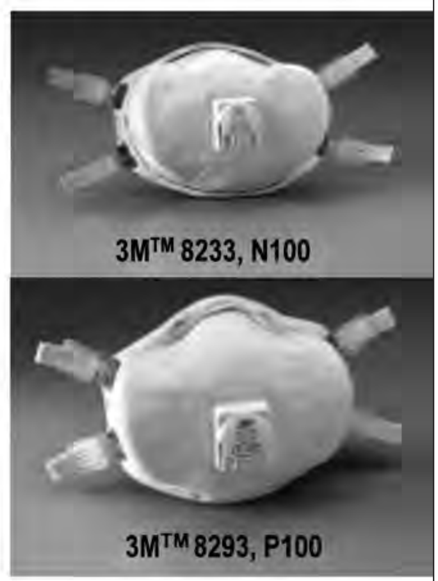


FIGURE 2A NORTH HALF FACE MASK SERIES 7700 & 5500 WITH 7580P100 FILTERS

FIGURE 2B 3M HALF FACE ELASTOMERIC RESPIRATORS WITH P100 FILTERS

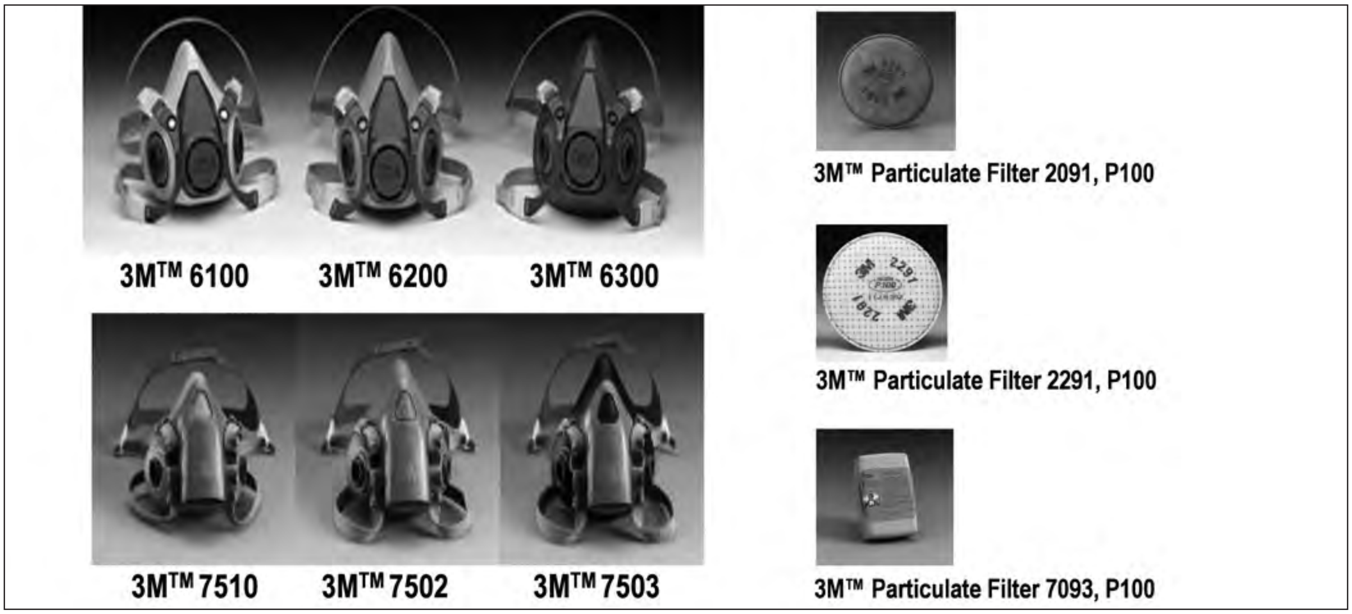


FIGURE 2C
NORTH LOOSE FITTING HALF FACE RESPIRATORS WITH P 100 FILTERS

FIGURE 2D
3M HALF FACE ELASTOMERIC RESPIRATORS WITH P100 FILTERS

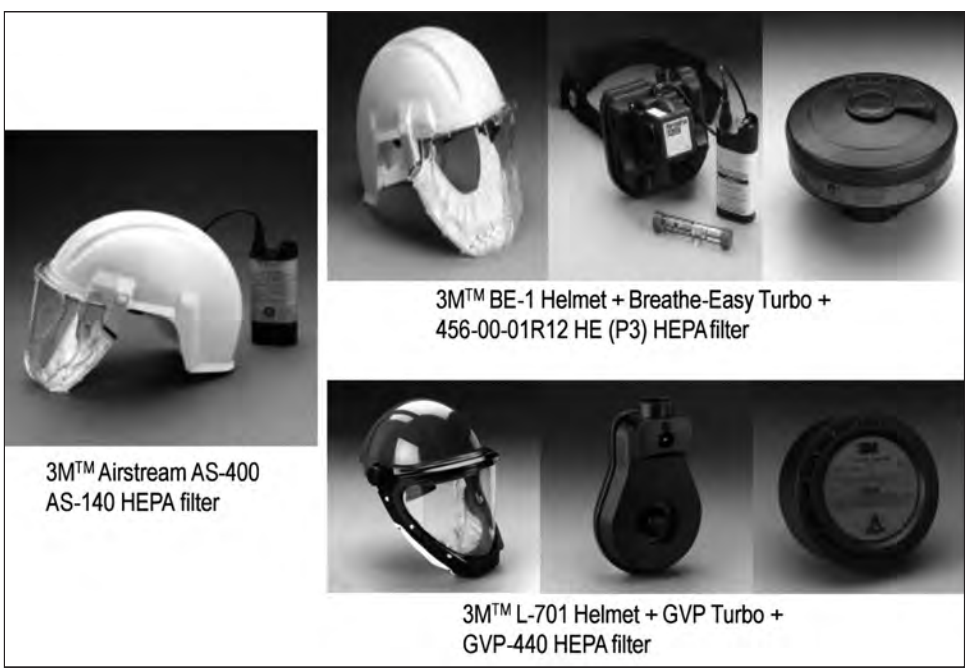


FIGURE 3A NORTH FULL FACE 7600 SERIES WITH FILTERS 7580P100

FIGURE 3B 3M FULL FACE ELASTOMERIC RESPIRATORS WITH P100 FILTERS

3M™ 6000 series full face respirator,

3M™ Particulate Filter 2091, P100

3M™ 7800s series full face respirator

3M™ Particulate Filter 2291, P100

3M™ FF-400 series full face respirator

3M™ Particulate Filter 7093, P100

FIGURE 4A NORTH FULL FACE AIR POWERED RESPIRATOR

54001 (shown with 7581P100 filtre)

54001W (shown with 7580P100 filter)

FIGURE 4B 3M MODEL 450-01-R20 FACE-MOUNTED POWERED AIR PURIFYING RESPIRATOR (PAPR) WITH HEPA FILTER

FIGURE 5A NORTH HONEYWELL FULLFACE AIR LINE RESPIRATOR MODEL 85505

FIGURE 5B 3M SUPPLIED AIR OPTIONS

Continuous-flow supplied-air systems are available in either high or low pressure configurations. A NIOSH approved system includes the headgear, breathing tube, air regulator and airline. The assigned protection factor is determined by the headgear (air-inlet covering).

Combination type respirators (supplied-air plus air-purifying) are also available.

7.5.3 Work areas where fibre concentrations are > 10 and ≤ 25 f/cc

The minimum requirement is a loose fitting, full-face, powered air-purifying respirator. The filters used must be class 100 (HEPA) **(Figures 3A, 3B and Table 2).**

7.5.4 Work areas where fibre concentrations are > 25 and ≤ 100 f/cc

The minimum requirement is a tight fitting, facepiece, powered air-purifying respirator. The filters used must be class 100 (HEPA) **(Figures 4A, 4B and Table 2).**

7.5.5 Work areas where fibre concentrations are > 100 f/cc

Although very unlikely, in the event that fibre concentrations exceed 100 f/cc, a supplied air respirator apparatus should be provided to workers **(Figures 5A, 5B and Table 2).**

7.5.6 Remarks

It is important to note that chrysotile dust is never IDLH (Immediately Dangerous to Life or Health), no matter what concentration levels are measured in the workplace.

Gas masks or chemical cartridge respirators do not provide effective protection against many kinds of dust and as such, their use is not recommended for chrysotile.

7.6 RESPIRATOR FACIAL FIT

The degree of protection afforded by a respirator requiring a tight facial seal depends on several factors, including:

- effectiveness of the seal to the facial skin;
- efficiency and capacity of the air-purifying or supply element; and,
- inward leakage through respirator components.

Efficiency and capacity of respirators are usually defined by the respirator equipment manufacturer and their instructions should be followed.

Leakage through respirator components can be eliminated by proper training, repair and maintenance procedures.

7.6.1 Qualitative Fit Testing (QLFT)

A qualitative respirator fit test must be used to determine the ability of each individual respirator user to obtain a satisfactory fit and an effective seal. The results of the fitting test, among other criteria, must generally be used to select the size and type of respirator.

a) Most models are available in small, medium and large sizes;
b) All qualitative fit tests on respirators with facepieces that require a tight seal in order to provide the user with proper protection must be conducted under negative-pressure conditions;
c) A fitting test should be carried out at least once a year (or at an acceptable frequency) for each wearer or whenever the wearer under goes physical changes, or work conditions necessitate a change in the type of respirator worn;
d) A fitting test must not be used to determine the efficiency or adequacy of air-purifying components in a respirator;
e) Under no circumstances may a person wear a respirator for which a satisfactory facial fit has not been obtained;
f) When other personal protective equipment, such as eye, face, head and hearing protection are required, these must be worn during the respirator fit tests to ensure that they are compatible with the respirator and do not break the facial seal;
g) Whenever possible, testing should be performed under conditions which simulate actual work practices;
h) A Qualitative Fit Testing (QLFT) must be performed and coordinated with your manufacturers' sales representative.
i) The assigned protection factor for each specific type of respirator is only valid once a satisfactory QLFT is demonstrated.

7.6.2 Fit Testing Records

Records of respirator fitting tests must be kept by the program administrator. The records must include, but not be limited to:

- name of the person tested;
- date and time of the test;
- specific make, model and size of the respirator;
- type of fitting test and test agent used;
- results of the fitting test;
- comments on test difficulties, interference by clothing, protective equipment that needs to be worn in conjunction with the respirator, personal fitting problems, (e.g. eyeglasses, dentures, unusual facial features, or facial hair); and,
- name of the person giving the test.

7.7 WHAT WE SHOULD KNOW ABOUT TRAINING

The following persons must be given adequate training by qualified personnel to ensure the proper use of respirators:

- respirator user;
- supervisor of persons using respirators;
- person issuing respirators;
- person performing fit tests; and,
- person maintaining and repairing respirators.

Records must be kept of the type of training each person has received and the dates when these training sessions occurred. The records must be kept by the program administrator for at least the duration of employment of the person trained.

It is recommended that a refresher course be given to all persons mentioned above on a yearly basis or when changes in the workplace dictate.

Instruction qualification
The instructor should be skilled in the art of teaching and communicating and possess the knowledge and skills identified in 7.7.1.

7.7.1 Training of Respirator Users

A minimum training program for every person required to wear respirators must consist of:

a) An explanation of the nature, extent and effects of airborne dusts to which the person may be exposed;
b) An explanation of the operation, limitations and capabilities of the selected respirator(s);
c) Instruction of the procedures for inspection, putting on and removing, checking fit and seals, and the wearing of the respirator. Sufficient practical experience must be provided to enable the person to be thoroughly familiar and confident with the use of the respirator;
d) Instruction on the maintenance and storage procedures required.

7.7.2 Training of the Supervisor

In addition to all of the items listed in 7.7.1, supervisory training should include:

a) selection, fitting, issuance and inspection of respirators; and,
b) monitoring of respirator use.

7.7.3 Training of Persons Issuing Respirators

A person assigned to the task of issuing respirators must be given adequate training and written standard operating instructions to ensure that the correct respirator is issued for each situation.

7.7.4 Training of Persons Maintaining and Repairing Respirators

A person assigned to the task of maintaining and repairing respirators must be given adequate training and written instructions in accordance with the requirements of item 7.9.

7.7.5 Training Records

A training record system that meets the requirements of the regulatory authority must be maintained.

7.8 KEY FACTORS FOR FIT TESTING

1. Persons using positive-pressure or negative-pressure respirators must be clean-shaven where the face piece seals to the skin;
2. Respirators requiring a tight fit in order to perform effectively must not be worn when an effective seal cannot be achieved and maintained;
3. Corrective eye wear necessary to the employee wearing a respirator must not interfere with the seal of the face piece to the face;
4. The use of contact lenses may be permitted by the program administrator after having considered those factors inside and outside the respirator face piece which could affect the eyes of the user;
5. No covering may be used that passes between the sealing surface of a respirator face piece and the wearer's face;
6. Other personal protective devices or equipment must not interfere with the seal of the face piece;
7. Persons who cannot achieve and maintain an effective closure of the respirator nose or mouthpiece must not be permitted to wear a mouthpiece and nose-clamp type of respirator;
8. Each user of a respirator must ensure that the respirator is in proper operating condition prior to each use;
9. The user of a respirator must check the seal of the face piece immediately after donning the respirator by internal company respiratory protection procedures or by procedures recommended by the respirator manufacturer.

7.9 CLEANING, MAINTENANCE AND STORAGE OF RESPIRATORS

7.9.1 Cleaning and Sanitizing

(Note: the following do not apply to maintenance free respirators)

a) Cleaning and sanitizing procedures should be included in the respirator wearers' basic training;
b) Cleaning and sanitizing must be performed on respirators on a regular basis;
c) Wearers must inspect their respirators before and after each use. Respirators must be cleaned and sanitized to protect the wearer from contamination;
d) In facilities where persons are responsible for the maintenance of individually assigned respirators, each person must be thoroughly trained in cleaning and sanitizing procedures. Appropriate cleaning and sanitizing materials must be made available;
e) In large facilities where respirators are used routinely, a centralized respirator cleaning area run by specially trained personnel can be provided.

7.9.2 Inspection

a) After being cleaned and sanitized, as specified in item 7.9.1, each respirator must be inspected and tested to determine whether it is in proper working condition. Faulty units should be repaired or removed from service;
b) Respirator inspection should include a check for:
   - tightness of connections;
   - condition of component parts (e.g. face piece, helmet, hood, head harness, valves, connecting tubes, harness assemblies and filters);
   - service life indicator;
   - shelf-life dates;
   - missing parts;
   - pliability and deterioration of rubber or other elastomeric parts;
   - proper functioning of regulators, alarms and other warning systems.

7.9.3 Storage

a) Respirators must be stored in a manner that will protect them against dust, ozone, sunlight, heat, extreme cold, excessive moisture, vermin, damaging chemicals, oils, greases, or any other potential hazard that may have a detrimental effect on the respirator;
b) Respirators must be stored in a manner that will prevent deformation of rubber or other elastomeric parts;
c) When respirators are stored in lockers or tool boxes, they must be protected from contamination, deformation and damage.

7.10 HEALTH SURVEILLANCE OF RESPIRATOR WEARERS

1. The program administrator or designate must determine whether or not a worker may be assigned to use a respirator;
2. Where the program administrator considers that, due to a person's fitness or ability, a medical opinion is required before wearing a respirator, that person must obtain this medical opinion from a physician who is knowledgeable about the work and the conditions of work of that person. The physician must inform the program administrator as to the fitness or ability of that person to wear a respirator. Details of any medical examination must not be disclosed unless consent has been obtained from the person so examined.
3. When possible, the following special tests can also be included in the baseline health examination:
   - electrocardiography;
   - pulmonary-function tests;
   - complete blood count; and,
   - biochemical profile of blood.

7.11 PROGRAM EVALUATION

1. The program administrator must periodically evaluate the effectiveness of the respiratory protection program to ensure that workers are being adequately protected;
2. The standard operating procedures should be reviewed annually by the program administrator or when work conditions change. Improvements should be made when necessary.

7.12 WEARER ACCEPTANCE

Wearer acceptance of respirators is an important factor to be considered in evaluating the effectiveness of the RPP. The respiratory wearers should be consulted periodically on the following issues:

- comfort,
- resistance to breathing,
- fatigue,
- interference with vision,
- interference with communication;
- restriction of movement,
- interference with job performance; and,
- confidence in the respirator's effectiveness.

7.13 REVIEW OF THE RESPIRATORY PROTECTION PROGRAM (RPP)

The RPP should be reviewed frequently (at least once a year) to ensure that:

- proper types of respirators are selected (for every work station and activity, based on dust concentrations);
- wearers are properly trained;
- correct respirators are issued and used;
- respirators are properly maintained;
- respirators are inspected;
- respirators are properly stored; and,
- respirators are properly worn.

7.14 REMEMBER AT ALL TIMES:

THE USE OF A RESPIRATOR SHALL ONLY BE CONSIDERED AS A TEMPORARY MEASURE AND SHOULD NOT BE ADOPTED AS A SUBSTITUTE FOR ENGINEERING CONTROLS OR A HOUSEKEEPING PROGRAM!

PART II - CLOTHES, WASHING FACILITIES & SERVICES

7.15 WORK CLOTHES

In accordance with the ILO Code of Practice and Québec health and safety regulations, a company must establish a policy concerning: work clothing, protective clothing, clothes washing, change rooms and lunchroom facilities.

1. Coveralls should be provided to each employee in contact with chrysotile, chrysotile containing products as well as other regulated materials;
2. Vacuum cleaners for de-dusting of clothes should be provided near the work area and/or near the entrance of the locker room where work clothes are removed and stored;
3. Brushes and compressed air are prohibited to clean work clothes;
4. Each employee exposed to chrysotile dust should remove dust from his clothes as soon as possible upon completion of work. Where a respirator is worn, it should be removed only after de-dusting;
5. It is prohibited to take work clothes home.

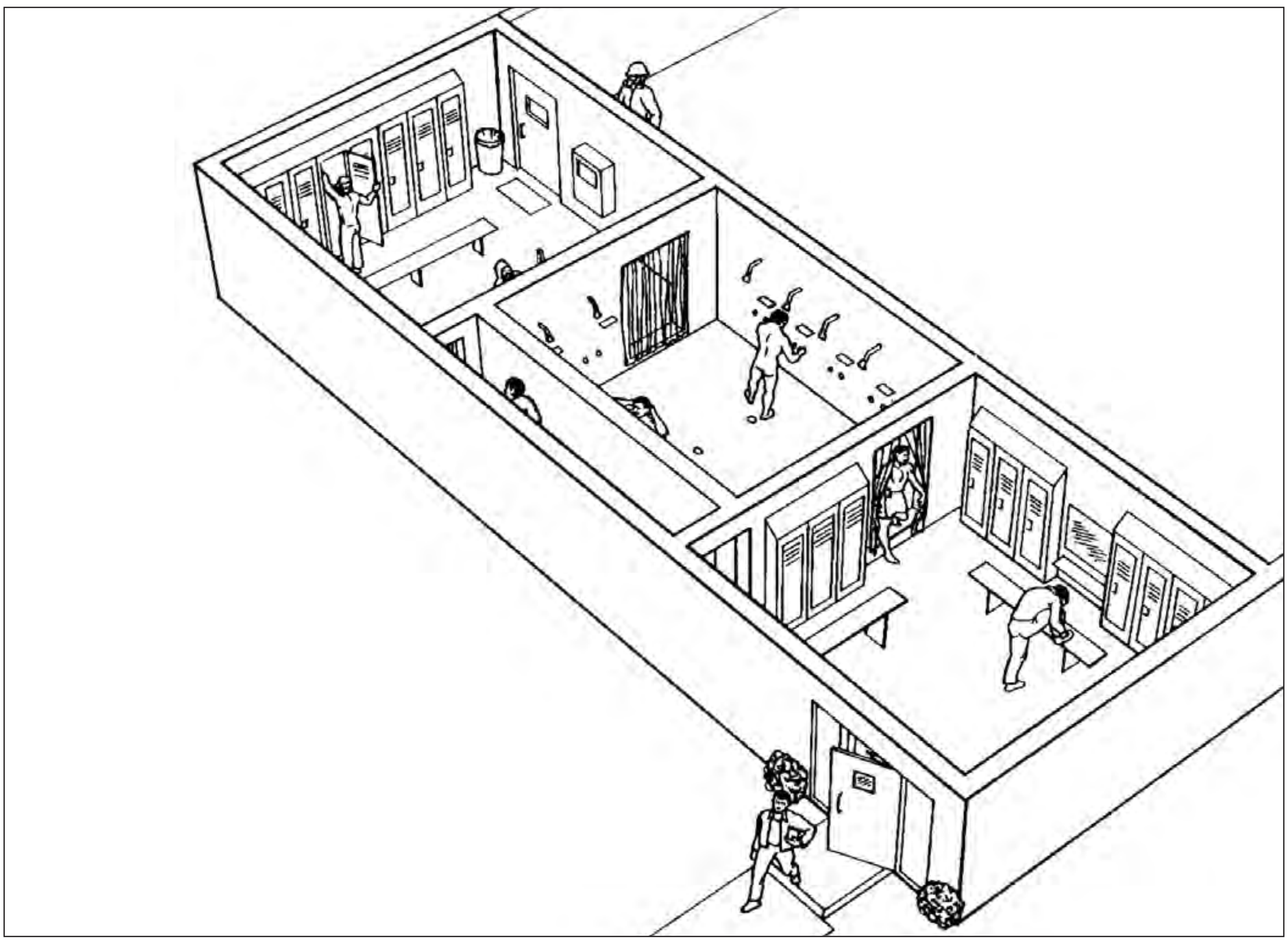
7.16 PROTECTIVE CLOTHING

1. Where dust concentrations exceed the permissible exposure limit value, workers should be provided appropriate respiratory protection equipment, as well as special protective clothing, to avoid contamination of working clothes;
2. This special protective clothing should consist of a one-piece, disposable hooded garment;
3. When a worker must wear special protective clothing, the following steps should be taken:
   - put on the special protective clothing;
   - install the respirator;
   - fix the hood over the respirator straps;
   - put on the safety boots ensuring the bottom of the pants are tucked in the top of the boots;
   - put on protective gloves ensuring the sleeves of the suit cover the top of the gloves;
   - put on safety hat.
4. Protective clothing must be removed immediately after usage and discarded in a special container.

7.17 USE OF WASHING FACILITIES, CHANGE ROOMS AND LUNCHROOMS

1. All employees working in direct contact with chrysotile must use the laundry system, provided by the employer, for their work clothes;
2. Coveralls or other working clothes must be collected on a regular basis. These should be laundered under controlled conditions to prevent the emission of airborne dust during handling, transport and laundering;
3. Where contaminated clothing is sent for laundering outside the factory, it should be packed in properly sealed, dust-proof containers;
4. These containers must be clearly identified as containing asbestos-contaminated clothing;
5. The shower facilities should be situated between the work area and the clean locker room (personal clothes) (see **APPENDIX 1** for model);
6. The company shall provide separate, individual lockers in order to keep separately the work clothes and the personal clothing;
7. The locker room area must be cleaned (inside and outside) regularly to ensure that there is no accumulation of dust;
8. No meals are to be taken into the workplace. A separate lunchroom must be made available to all employees. Prior to entering into the lunchroom during a work shift, special protective clothing must be removed and regular coveralls cleaned with a HEPA vacuum. This room must be isolated from the work area;
9. Employees from other areas or outside contractors must follow the same rules as employees within the area where personal protection measures are required.

APPENDIX 1 CLOTHES, WASHING FACILITIES AND SERVICES



8

Waste Handling

8. Waste Handling

INTRODUCTION

Disposal of asbestos waste is becoming increasingly expensive and subject to more and more stringent regulations. In these circumstances, the best solution is to avoid, or minimize to the extent possible, the amount of waste created by adopting the most efficient production techniques, including recycling. Alternatively, some chrysotile waste (e.g. brake linings) can be used as a raw material for other chrysotile using industries (e.g. roof coatings). Where it is impossible to avoid the creation of waste, it must be handled, transported and disposed of in accordance with local (municipal), national regulations or international practices.

8.1 TYPES OF WASTE

Chrysotile and asbestos waste can be divided into five categories:

8.1.1 Hard Waste

Included in this category are the following: bonded chrysotile, chrysotile cement, jointings, bitumastic rubber residues, offcuts and rejects. Hard waste grinding techniques are well established and reliable equipment is available on the market.

Better production control and better housekeeping should be considered first, so as to reduce to the absolute minimum, the quantity of hard waste produced. Only then should recycling, through grinding, be considered to further reduce the amount of waste to be disposed of.

If production facilities or the product itself does not permit recycling, the waste should be stored in identified containers close to the production area generating the waste and in such a manner so as to ensure that it will not be abraded or crushed while awaiting disposal.

8.1.2 Wet Waste (sludge or slurry)

Given the fact that sludge recycling is problematic, it is of paramount importance to avoid excessive sludge production in the first place. If sludge production is unavoidable, recycling possibilities must be explored. Various techniques have been developed to this end. All have attempted to re-use sedimentation basins and improve the raw material yield of the process.

Technologies have been developed to reduce the volume and weight of sludge by dewatering prior to transport to the disposal site. This not only reduces transportation and disposal costs, but also increases the stability of the disposed waste. Equally important, dewatering allows the disposal of larger quantities of sludge in the same (usually limited) space in the disposal site.

The slurry should be loaded into specially designed carriers or other containers to ensure that no spillage occurs.

8.1.3 Friable Waste

Friable waste is waste capable, when dry, of being crumbled, pulverized or reduced to powder by hand pressure. Sources of friable waste in a factory setting include: fine dust produced from debagging facilities, material conveyors, mixing equipment or such processes as sawing, sanding or machining, as well as waste products from the bag house or industrial ventilation systems. On construction sites, waste from friable insulation removal activities is a major source of asbestos waste. Other sources of friable waste include: fine dust generated by cutting high-density products with high-speed tools without appropriate engineering controls; and residue dust on brake drums in brake maintenance and repair shops.

Friable waste should be put in properly labelled, polyethylene bags with a recommended minimum thickness of 6 mil. Bags should be sealed immediately after filling, and stored in an area where they cannot be broken or otherwise disturbed.

Where activities involving the disturbance of friable waste are likely to generate airborne fibres at concentrations which exceed permissible exposure limit values, workers should be equipped with appropriate personal protective equipment.

8.1.4 Bags

Sacks or bags which have contained loose chrysotile fibres, or mixtures including loose chrysotile fibres, should be deposited in a suitable receptacle, under a dust extraction hood immediately after being emptied. When possible, the bags should be shredded and recycled in the process.

For disposal, bags should be sealed in an impermeable bag and deposited in an appropriate landfill. A further method of plastic bag disposal is melting. By melting the empty bags and wrappers, the chrysotile residue becomes embedded in the melted plastic.

Under no circumstance should bags be reused for packing or other purposes.

8.1.5 Process Water - Effluent Discharge

In most countries water is an expensive commodity. Even more expensive is the discharge of used water where stringent legislation is in force. In general, effluent must undergo a series of successive treatment processes to ensure that the discharged water will cause no harm of any kind. Discharge conditions may vary by industry. Nonetheless, it is worthwhile, for environmental, legal and economical reasons, to try to reduce effluent discharge to an absolute minimum.

Operation in a fully closed circuit (zero waste) is not a myth but a real possibility. Any closed circuit is possible for plants of chrysotile cement when the composition of the cement is good enough to produce C/C products.

However, discharge of process water can, in most cases, be drastically reduced through good housekeeping and stringent control of unnecessary clean water inputs into the production circuit.

8.2 TRANSPORT OF CHRYSOTILE AND ASBESTOS WASTE

Chrysotile and asbestos waste whether loose or in sealed containers, should be transported to the disposal point in such a way that no dust is emitted into the air.

In the event of accidental spillage (for example, as the result of a road accident) during transport to the disposal site, action appropriate to the extent of the spillage should be taken immediately.

Where the amount of spilled material is small, the waste should be collected into its original receptacle and reloaded without delay.

If the spillage is substantial and the material dusty, it should be wetted, if practicable, and covered immediately. The material should then be removed. During this process appropriate safety precautions, which may include the use of protective clothing and respiratory equipment, should be taken.

8.3 DISPOSAL OF CHRYSOTILE AND ASBESTOS WASTE

Waste disposal requirements depend on whether the asbestos waste is friable or non-friable. Some jurisdictions in North America do not consider non-friable or hard waste, as a hazardous waste. Non-friable asbestos waste can be disposed of in any landfill, including municipal landfills that handle everyday household waste, as long as it is covered daily by other material.

For friable asbestos waste, more stringent requirements may apply. Local authorities should be contacted on this subject.

8.3.1 ILO Guidelines

The ILO Code of Practice “Safety in the Use of Asbestos” also provides general guidelines for asbestos waste disposal.

1. Before a site is used for the disposal of asbestos waste, care should be taken to establish that the site is both suitable and acceptable for the purpose;

2. The disposal site chosen should have vehicular access to the working face, or to a hole or trench dug to receive the asbestos waste;

3. The waste should, wherever practicable, be deposited at the foot of the working face of the landfill site or at the bottom of an excavation dug for it;

4. Where the waste has to be deposited from above the working face, or into an excavation, care should be taken to prevent spillage from bags;

5. When deposited, all waste other than high-density waste should be covered to an acceptable depth (for example 20-25cm [8-10 in.]) as soon as possible. No asbestos waste should be left uncovered at the end of a working day;

6. If wet waste is deposited, it should be covered in the same way as dry waste to prevent the escape of asbestos dust on drying out;

7. Wet pits should not normally be used for the disposal of any asbestos waste other than high-density material;

8. Where high-density waste is deposited on a dry site, care should be taken to ensure that it is not ground to dust by the passage of vehicles over it.

8.3.2 General Advice

If there are no landfills specifically approved for friable asbestos waste in your country, the best alternative is to use an industrial waste disposal site with a specific approval for asbestos containing waste. In the event neither is available or feasible, use a sanitary waste fill that meets the conditions required for disposal of asbestos containing waste and request an official approval.

Any asbestos waste awaiting disposal should be identified by means of a label on the corresponding container. In some jurisdictions, a register must be kept to indicate volumes, composition and localization of asbestos containing waste.

8.3.3 Personal Protection and Hygiene

Workers occupied in the collection, transport or disposal of asbestos waste, and who may be at risk of exposure to airborne dust, should be provided with suitable respiratory equipment and protective clothing.

Where vehicles and reusable receptacles and covers have been in contact with chrysotile waste, they should be cleaned after use by means of a vacuum cleaner or by an alternative dustless method, such as washing.

8.3.4 Supervision

Where a company disposes of its own chrysotile waste, written instructions should be issued to the workers concerned. Periodic supervision should be undertaken to ensure that the necessary safety precautions are being followed.

If a waste disposal contractor is employed, the relevant sections of the ILO Code of Practice should be incorporated in the contract.

The contract should state that the contractor is responsible for ensuring that safety measures are observed at the disposal site.

Periodic checks should also be made by the undertaking to ensure that the contractor is observing the ILO Code of Practice.

9

Medical Surveillance

9. Medical Surveillance

INTRODUCTION

Medical surveillance refers to the administrative and clinical procedures relevant to the supervision of the health of workers. All workers, whether they are employed in production, administration, sales or supervisory capacities should be covered by a health monitoring program.

The ILO Code of Practice on Chrysotile Asbestos provides useful guidance. In general, workers' health supervision should include:

1. A pre-assignment medical examination;

2. Periodic medical examinations;

3. Medical examinations in and where practicable following cessation of employment.

9.1 HEALTH MONITORING PROGRAMS

9.1.1 The objectives of the pre-assignment medical examinations are:

- to determine any condition which would be contradictory to occupational exposure to chrysotile dust;
- to establish baseline records for the future supervision of the health of workers;
- to educate and advise workers about the risks associated with exposure to chrysotile dust and other contaminants.

9.1.2 The objectives of periodic medical examinations are:

- to detect the earliest signs of asbestos related disease;
- to detect any significant change in health status relative to the baseline examination;
- to continue to educate and advise workers about health risks and to ensure that appropriate preventive measures are being taken to minimize risk.

9.1.3 The objectives of medical examinations in relation to cessation of employment.

Working disabilities medical examinations are used to:

- confirm with certainty the presence of the illness
- evaluate the condition of the disease (evolution);
- evaluate the stage of the workers disease and set, if necessary, working disability modalities or any modification of the employees' task.

9.1.4 Only professionally qualified doctors specialized in asbestos radiographic analysis can perform medical examinations in accordance with national laws and regulations.

9.1.5 These medical examinations will be performed free of charge to the employees and if possible during working hours.

9.16. The employees who submit themselves to the health monitoring have the right to:

- confidentiality of personnel and medical information;
- detailed explanation of the objectives and the results of the health monitoring;
- refuse or accept medical procedures that could be detrimental or cause problems;
- be informed of possible chrysotile related disease.

9.1.7 Copies of medical records should remain at the disposal of employees, or upon request made available to their personal physician.

9.1.8 Medical surveillance must never be used to replace environmental surveillance or effective engineering controls.

9.2 MEDICAL EXAMINATIONS

9.2.1 The medical examination should include:

- a clinical examination;
- an X-ray of the thorax;
- a lung function test (spirometry);
- other appropriate examinations.

9.2.2 At each medical examination, the doctor should advise the worker about the health risks of chrysotile, and in particular, the synergism between smoking and asbestos exposure.

9.2.3 The risks of smoking include the following:

- fibrosis of the lung tissue;
- lung cancer;
- significant reduction of respiratory capacity;
- emphysema;
- cardio-vascular problems;
- others.

9.2.4 Smoking significantly increases the risks of health problems. Seminars should be held regularly to encourage workers to quit smoking.

Frequency

a) In Quebec, employees in contact with chrysotile asbestos must be examined every 3 year.

b) Employees not in contact with chrysotile must be examined every 10 years.

c) In special circumstances (e.g. when there is some suspicion of a possible asbestos related disease or there has been long-term exposure), the examining doctor may specify more frequent examinations.

d) After the examination the doctor must issue an occupational health certificate.

e) The doctor must make written recommendations to the company's management (e.g. on individual protection, on preventive measures, on withdrawal from all asbestos exposure, etc.). Management must respect these recommendations.

Record Keeping

a) All medical documents must be filled and kept during a minimum of 20 to 40 years after cessation of employment, depending on the country. In Québec, records are kept indefinitely.

b) A register of every person on the payroll must be kept indicating:
   - dates of medical examinations and the location of the results;
   - last date of employment.

c) Depending on government regulations, the data can be transferred to a central filing system, but confidentiality must still be enforced.

9.3 ROLE OF THE MEDICAL DOCTOR

9.3.1 Periodical communication between the doctor and the plant manager must be organized. The agenda and decisions of these meetings must be recorded in writing.

9.3.2 The medical doctor must:

- visit the plant regularly;
- be informed of the monitoring and results and analyze them;
- be informed of workers' individual exposure conditions.

9.3.3 The most advanced legislation in Canada concerning health surveillance exists in the Province of Quebec, where almost all of the asbestos mining and milling takes place. Existing legislation allows workers to choose their occupational physician in joint decision made by the Joint Occupational Health and Safety Committee. The selection is made from a list of occupational physicians supplied by government community health services. It is the responsibility of the government physician to prepare the medical surveillance program, in cooperation with the workers' and employers' representatives. The joint committee has the power to approve such a program, which comprises both the regulatory measures and those developed in conjunction with the physician. In case of a dispute, government arbitration is enacted.

10

Information and Training

10. Information and Training

INTRODUCTION

Information and training are the most important elements of a company's preventive and control program. Investments in industrial ventilation systems, debagging units, enclosed conveyor belts, special hoods, etc., will be rendered meaningless if the work force, including management, supervisors and workers, are not well-informed and trained regarding the important role it has to play in the company's prevention and control program. For example, if a debagging station is poorly maintained, little or nothing will have been gained by purchasing this equipment. However, a properly maintained work station by a well-informed worker will ensure the effectiveness and efficiency of engineering controls and a clean and safe workplace environment.

All categories of personnel involved in the prevention of chrysotile related diseases, such as: managers, supervisors, workers and members of the joint health and safety committee, should be given appropriate training. This overall approach will be similar for each level of responsibility, with more emphasis placed on different parts of the program given according to line of duty.

10.1 MANAGEMENT

Management must be made aware of the potential hazards associated with asbestos fibres, including chrysotile and the general preventive measures, such as:

- the compounded risks associated with smoking and chrysotile exposure;
- the work stations and jobs requiring special protective measures;
- personal protective equipment;
- good industrial hygiene practices;
- the importance of regular medical check-ups and the reasons for the different medical tests to be undertaken;
- the need to comply strictly with in-place regulations regarding the controlled-use of asbestos, including chrysotile;

10.2 SUPERVISORS

Supervisors should require similar training with some subjects covered in greater detail. These include:

1. The relationship between chrysotile exposure and smoking and the risk of lung diseases;

2. Preventive and control measures, including equipment and ventilation controls which are required. The importance of proper maintenance in assuring good ventilation throughout the operation should also be stressed;

3. Special personal protective equipment which may be required for certain types of work, especially for maintenance workers and under conditions where the ventilation system is not operating properly;

4. The need to make available to all workers respirators and other protective equipment, particularly when it is believed that the permissible level may be exceeded. Special training is also required to ensure that all employees use the respiratory protective equipment (RPE) correctly;

5. Industrial hygiene practices, including the need for air monitoring and the proper interpretation of the results obtained;

6. Health problems, the need for medical examinations, the types of tests required (e.g. X-rays of the thorax, pulmonary function tests), the significance of these tests' results and the principles of preventive detection;

7. Caution signs and labels with special emphasis on those areas where special care must be taken to protect workers.

10.3 WORKERS

Workers should receive the same type of information as supervisors at the start of employment and periodically thereafter. Concrete examples and case studies should be provided. Particular emphasis should be given to the appropriate preventive and control measures pertinent to each work station. New employees should be rigorously supervised until fully trained.

The information given to workers should be in both written and verbal form, in a language familiar to all employees. Examples of the training pamphlet given to a typical chrysotile mine worker in Quebec is provided in **APPENDIX 1**.

Because the risks of lung disease from chrysotile exposure are significantly greater in smoking populations, specific information regarding the nature of this interaction and the general risks of cigarette smoking should be provided to all workers.

An easily visible sign should be posted in all workplaces where chrysotile dust is generated. It should clearly identify the hazards of chrysotile exposure and the associated health effects.

10.4 JOINT HEALTH AND SAFETY COMMITTEE (JHSC)

This committee is essential for the successful development and implementation of a company's preventive and control program. It represents a vehicle of open cooperation between management and labour, whose sole purpose is to achieve and maintain a healthy and safe workplace environment.

The establishment of a joint committee should be mandatory in all chrysotile operations. At a minimum, the JHSC should consist of 2 or 3 employer representatives and an equivalent number of worker representatives. The committee should meet during regular working hours, at least four times a year, but not more than once a month.

The joint committee has a number of functions. These include the choice of personal protective equipment, training and information programs, choice of occupational physician and approval of the overall health program. It also reviews, on a regular basis, the company's preventive and control programs and makes observations in the following areas:

- environmental standards, codes and schemes of practice;
- standard work procedures for existing and new methods of work and equipment;
- modifications/extensions of the plant;
- education and training for health and safety;
- maintenance of tools, equipment and processes;
- the choice and proper use of protective equipment;
- the efficient use of ventilation;
- the hazards related to production and maintenance;
- the use of hazardous chemicals;
- housekeeping.

Other functions of the joint committee include:

- participation in the assessment of risks associated with specific job positions and the overall risks of contaminants (fibre);
- to record accidents and cases of occupational disease as well as incidents which could have caused them;
- to investigate such accidents, diseases and incidents and make recommendations to the employer and government inspection services;
- to act on employees' suggestions and complaints;
- to study inspectors' reports;
- to record statistical data from the physician, the community health services and inspection services.

To be effective, the joint committee should have ready access to all information necessary to carry out its responsibilities. Occasionally, it is hoped that a physician, an industrial hygienist and/or other resource persons should participate in tours of the facilities along with JHSC members, so that they can add insights and perspectives to the joint committees long-range planning and work.

Committee members will need to have specific training regarding the committee's role and duty to the company. More specialized training may be necessary, particularly with respect to personal protective equipment, air monitoring, national regulations and other aspects of safety.

10.5 WARNING SIGNS

Warning signs are required and should be located at the entrance to each restricted area. In the chrysotile industry, there are several common signs, such as: "No smoking allowed in this area", "The use of respirators is required", "Coveralls required in this area" and "the use of hearing protection is required in this area", **(APPENDIX 2)**. Management, supervisors and workers must obey these signs in order to protect themselves.

The signs and labels must be clear and concise and easy to understand. Pictograms, approved by the health and safety committee, are recommended. Their importance must be explained to the workers. In addition, periodic checks should be made to ensure their use is still valid.

APPENDIX 1 - INFORMATION AND TRAINING GIVEN TO NEW EMPLOYEES

A minimum of two days should be planned to inform and train a new employee.
The recommended programme's content is as follows:

Day One

A.M. The new employee is directed by the personnel department to the safety director who provides information on the following subjects:

1. Health & safety policy of the company;
2. Company's safety regulations and work practices, including environmental programs;
3. Video presentations of the operations
   Video presentations of WHMIS (Workplace Hazardous Materials Information System);
4. A visit of the plant with emphasis on the work area where he/she will be working;
5. A visit to the hygiene department, where information is provided on the preventive and control measures taken to protect the health of workers (dust and noise monitoring).

P.M. The training department provides information on the following subjects:

1. A video of the work station where he/she is going to be assigned;
2. A presentation of the work task in his/her field of application;
3. A visit of the plant with an emphasis of his/her workplace and work procedures.

Day Two

The training department representative goes to the workplace with the new employee and presents him/her to the shift boss and the workers with whom he/she will be in contact with. Thereafter, the work which will have to be undertaken will be demonstrated, along with the good work practices and safety procedures to be followed and respected.

The new employee goes to work, as any other worker, with the exception that the shift boss is asked to closely supervise his/her work in order to correct any inappropriate work habits or practices.

APPENDIX 2 - WARNING SIGNS

11

Implementation

11. Implementation

11.1 THE EXPERIENCE OF THE QUEBEC MINING INDUSTRY

The chrysotile mining industry in Quebec has been operating for more than 130 years. Its development and growth has had a very significant and beneficial effect on the economy of the surrounding communities, the province and the country. However, as it is nearly always the case, these benefits have not been achieved without some undesirable side-effects. As the mines grew, the members of the mining industry recognized early the fact that they must share the hard-won knowledge regarding preventive and control programs.

In the 1960's, the industry embarked upon a program to bring all the mining and milling operations within safe limits. Later, some companies made their objective 50% of the permissible exposure limit values for chrysotile. This objective and the decision to protect the environment and people at work as well as at home were adopted as policy.

Corporate policy on this matter was clearly stated by the president and made known to all employees. Within each company, a senior manager was assigned responsibilities related to protection and prevention of occupational risk and environmental protection.

Each company had a joint health and safety committee that included representatives from management and employees. In order to establish an action plan and respond to various problems, the following mechanisms were adopted by each committee:

- a coordinator, named within management, reported to the president;
- meetings were scheduled at monthly or quarterly intervals;
- the committee reported on problem areas and ways to solve them (eg. equipment, procedures);
- following the committee meetings, the coordinator prepared a plan of action indicating the problem, a proposed solution, estimated completion time and costs;

One of their first tasks was to analyze and pinpoint areas of most concern. They prepared a layout of the plant with emphasis on areas with the most serious problems in visual airborne dust. A monitoring survey, including results of fixed and personnel stations, was also evaluated to provide a global picture of the plant.

Once the mines had established a plan of action, it was necessary to assign priorities to each problem based upon the amount of dust emission, the number of employees exposed and the resources available. Identifying the principal problems and setting proper priorities are extremely important points to an action plan.

Some guidelines used by the mines were:

- setting-up a list of problems by degree of dust emission, starting with the highest;
- choosing the highest contaminated area affecting the most employees and assigning it a high priority;
- all items on the list with no cost should be implemented immediately. This usually applies to procedures, work habits, housekeeping;
- obtaining approval for yearly monetary allocations from management;
- providing estimate of the time required and costs of solving the problem.

At the chrysotile mines, priorities were closely followed and updated as work progressed.

Based on the experience of the chrysotile mining industry, situations will arise when the chrysotile dust emissions exceed legislated limits. This cannot be tolerated. To prevent employees from being in a contaminated area, unacceptable situations must be addressed promptly. Because the health of the employees is of the utmost concern, the first step is to require all employees to wear appropriate respirators and personal protective clothing. However, personal protective equipment must be viewed only as an interim measure. The workplace environment must be made clean and appropriate engineering solutions developed and put in place.

The important role that workers have to play in achieving and maintaining clean and safe workplace environment were recognized at an early stage. Training programs were developed by joint health and safety committees and all employees were required to participate. And this was not a one shot effort. Employees were given training prior to the commencement of employment.

The industry was also committed to the professional development of its engineers and industrial hygienists. Their participation in specialized training programs enabled the industry to develop in-house expertise which permitted the development and implementation of state-of-the-art prevention and control programs.

When programs extend over several years, as was the case in the mining industry, it is important to divide the program into stages. The first goal should be to meet the regulatory limits. Depending on present dust emissions, the goal could aim for a reduction of 50% and subsequent goals could be a reduction of 20% until regulatory limits are met.

Even once regulated limit values are achieved, the job is not done. It is important to stay ahead of the game and anticipate pressure from government authorities to lower exposure limit values. It is therefore important to maintain an active research and development program to develop practical, low-cost solutions and to overcome any technological roadblocks which may be impeding progress in a certain part of the plant. Although mining is much different than product manufacturing, if the industry did not maintain a strong research and development effort to overcome some of the technical problems experienced in various parts of the mill, it is not clear that the mines would be in business today.

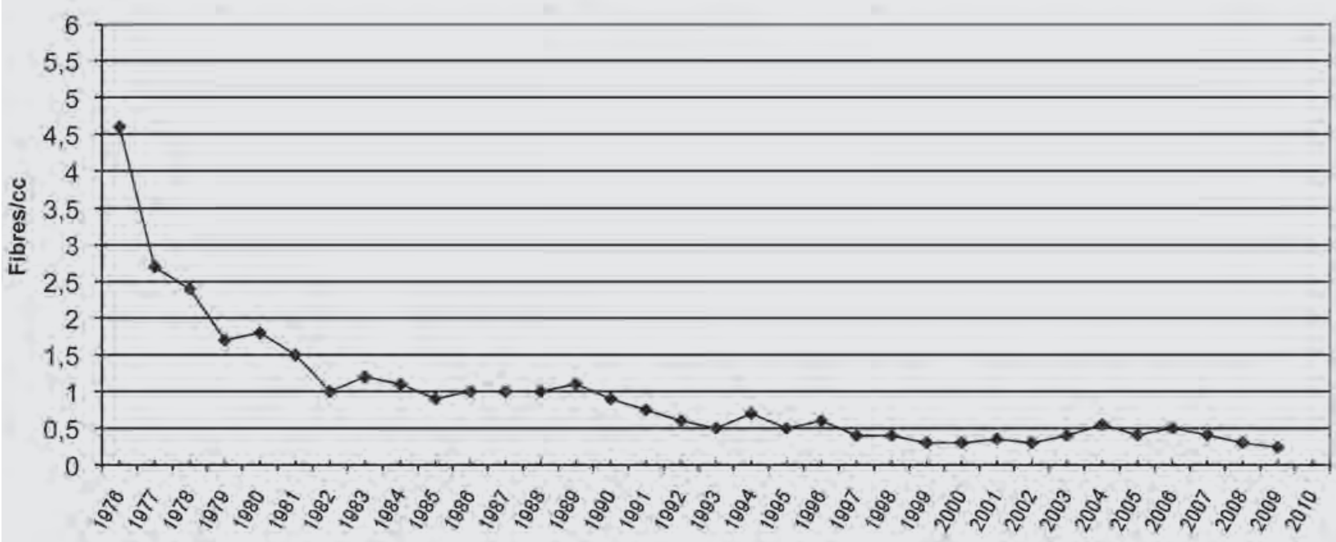
All of the companies engaged in mining and milling chrysotile fibre in Quebec are members of the Quebec Asbestos Mining Association (QAMA). Although the companies are business rivals, they all share the common desire to protect employees and the communities from the potential risks association with their operations. In the sixties, the QAMA created an environmental control committee, where all the ideas were pooled and through which the combined knowledge of the industry was freely exchanged and put to work. To further strengthen this effort, the QAMA hired an engineer to guide the project.

The chrysotile mining industry in Quebec has recognized the need to adequately monitor the environment and members have combined their resources towards this end. Therefore, each mine experimenting with a new system has communicated the results to all other mines. They have agreed to open their doors to each other and to supply sketches and specifications. This prevents the duplication of efforts and allows for a wider spectrum of research. Finally, the Association actively contributes to information exchanges among the various national and international technical committees.

Active involvement and the commitment of management, employees, engineers, maintenance workers and environmental inspectors resulted in solutions to difficult problems and substantial reductions of dust emission points throughout the plants. Often this was the result of sharing the hard-won knowledge among the member companies.

Now, to answer the first two questions you may have been asking yourself; will it work?

GRAPH 1 AVERAGE CONCENTRATIONS OF CHRYSOTILE FIBRES IN THE QUEBEC CHRYSOTILE MINING INDUSTRY

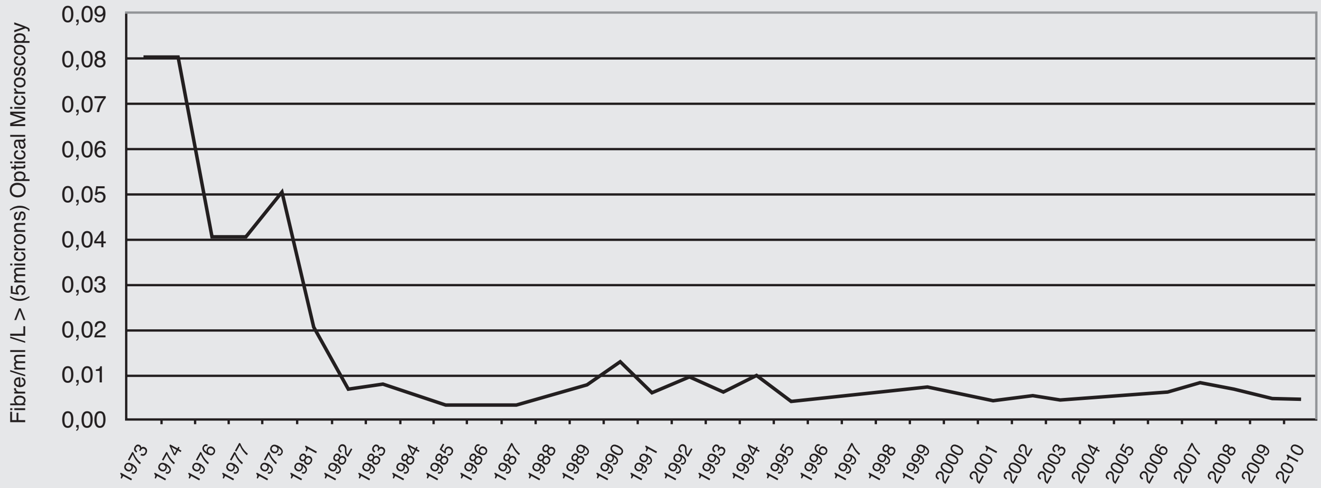


Concentration in fibre >5 microns per cubic centimeter in the Québec chrysotile mining industry since 1976

You can see from the attached **Graph 1** (average concentrations of chrysotile fibres in the Quebec mining industry), significant improvements can be accomplished over a period of time.

This same approach was employed by the chrysotile producers to protect the communities from the undesirable features of chrysotile mining operations. Active involvement and commitment has resulted in solving such difficult problems as air pollution associated with drying chrysotile ore, disposal of tailings and dust created by the primary drills in the open-pit operation.

GRAPH 2: CHRYSOTILE FIBRE CONCENTRATIONS IN QUEBEC CHRYSOTILE MINING TOWNS



*All types of fibres meeting dimension criteria are counted as prescribed in the standard method by phase contrast optical microscopy (PCOM) L >5 microns ; D < 3 microns ; L/D > 3:1

Results of these improvements aimed at providing clean air in the mining communities is clearly demonstrated on attached **Graph 2**.

As an industry, we have also learned that it is important not to be satisfied only with accomplishments achieved at our individual operations. To secure the long-term future of the chrysotile industry, we have also realized that we must look downstream to our customers and to encourage them to look downstream to their customers and users of chrysotile products. Like a steel chain, we are only as strong as our weakest link. And, if chrysotile or chrysotile containing products are being misused or mishandled at any point of the product's life cycle, it could have long term repercussions for the industry as a whole.

In talking about prevention and control, it is therefore important to look beyond the plant gate. Your local industry association can be extremely useful in terms of developing and distributing information pamphlets, leaflets as well as coordinating your industry's public communications program. This may seem a burden, but chrysotile asbestos is not unique in this regard. Many industries are facing similar pressure and several have responded by developing aggressive product stewardship programs (PSP). The PSP adopted by the refractory ceramic fibre industry is quite pertinent and provides a fitting summary and conclusion for this information and training exercise:

11.2 KEY ELEMENTS OF A PRODUCT STEWARDSHIP PROGRAM (PSP)

1. Over time, a product stewardship program is likely to affect many aspects of your business. Insure that top management is committed to the program. Participation and input are needed from all levels in the organization, but if top management is not fully supportive, the program is unlikely to succeed. The basic rationale for product stewardship is rooted in fundamental attitudes on ethics and values. Top management must take the lead on such issues. Moreover, stewardship issues frequently cut across organizational lines making decentralized management difficult.

2. Create a "bias for action." Identify key portions of the program and get these underway promptly. There is generally ample time for mid-course corrections to the program as new data, facts and priorities emerge.

3. The list of possible activities of a PSP is long. Set priorities on possible initiatives. Identify short-, intermediate-, and long-range goals. Focus is important. Avoid setting goals that are ill-defined or excessively ambitious. Many published PSP's are so broad and full of generalities, as to be useless in practical terms. Keep it relatively simple at first. An excessively broad program invites cynicism and ultimately, failure.

4. Where possible, identify and track quantitative measures of program effectiveness. Charts depicting time trends in these measures of effectiveness are good as visual indicators or

program challenges and successes. If workplace exposures are particularly relevant, for example, then relevant exposure and concentration statistics should be tracked.

5. Be sure to emphasize communications in the PSP. Communications must be directed to employees, customers, regulatory agencies, and other constituents as necessary. Follow-up, where possible, to insure that these communications are being received and understood.

6. Be objective in assessing program results. A frank assessment of failures as well as successes is ultimately in everyone's best interest. Regulatory agencies and others may be critical of failures, but you will gain credibility and trust for having brought these to their attention.

7. Involve your customers. Without their full support, no program can be truly effective. Seek to organize similar programs among your customers. Customers always appreciate technical service, and a good PSP is a way to build customer loyalty. Moreover, customers can often contribute useful ideas to a PSP.

8. Products and processes that have potentially adverse health, safety or environmental effects are likely to be regulated. Accept this premise and be pro-active in dealing with regulatory agencies. The lessons learned as a result of stewardship activities should enable you to suggest economically efficient control alternatives. Unless you feel strongly that proposed regulations are arbitrary and capricious, do not waste time and effort with adversarial behaviour.

9. Use objective outside advice to the extent needed. Attorneys, consultants, and other specialists can make useful and sometimes pivotal, contributions to the design and management of a stewardship program. But, do not cede ownership of your program. The long-term success of your program is critically dependent on in-house personnel. Assign some of your best personnel to the PSP. This not only insures that good ideas are available, but underscores your commitment to the program.

10. Stress continual improvement in measures of program effectiveness. A compliance-based approach can be effective, but an emphasis on continual improvement is preferable.

11. Audit results of the PSP and use results of these audits to restructure the program. Quantitative measures (see point 4) of program performance and definable goals are easier to audit.

12. Relate to the above point, if audits or other emerging developments show negative results, do not seek to punish those responsible. Instead, look for constructive solutions to problems. Be mentally prepared for adverse developments. Progress is not always continuous. Problems, when found, do not always indicate that things are getting worse. Rather, these may reflect the fact that you are aggressively searching for them.

13. Identify and try to maintain a dialogue with potential critics. Vocal critics are often difficult and irritating to deal with. However, it is a capital error to disregard their concerns. Use meetings with critics to define areas of common ground as well as points in dispute. Try to understand their point of view.

14. Make bold decisions when these are called for. Withdrawing a product line or making a substantial capital investment, for example, could be painful choices - but well worth the price if they can ensure the protection of worker health and safety and the survival of the business.

11.3 IMPLEMENTATION OF PREVENTIVE AND CONTROL PROGRAMS - A Case Study (Hypothetical case in the 1980's)

Scenario

Small company (50 employees) engaged in manufacturing bonded chrysotile products: President directs operations himself, with assistance of a small staff, including production supervisors.

Plant Conditions:

- Poor housekeeping: (e.g. loose fibre on the floor, empty chrysotile bags lying around; waste material accumulating on machinery and building structure; broken bags in storage and production area).
- No Industrial ventilation system
- Conveyors not enclosed
- Visible dust concentrations at debagging and mixing stages
- Respiratory protective equipment not provided to workers
- No lockers, washing facilities, work clothing provided to workers

Step 1

- Establish corporate policy to be a responsible employer and provide a healthy and safe working environment;
- State this commitment in writing. Have it signed by the President and circulate it to all employees (see **APPENDIX 1**);
- Join local industry association

Step 2

- Assign responsibility to a senior production supervisor to develop and implement a preventive and control program;
- Engage outside expert(s) (within or outside industry association), to undertake full evaluation of plant with following objectives:
    - a) Establish baseline airborne concentrations at all stages of the production process and in all areas of the plant using personal and static sampling techniques;
    - b) Identify all sources of dust and cost-effective solutions to reduce exposures to acceptable levels;
    - c) Establish priorities and cost of preventive and control measures to ensure compliance with all regulatory requirements.

Step 3

- Establish joint health and safety committee, complete with management and labour representatives, with meetings to be held on a regular basis (see **APPENDIX 2** for minutes of a typical meeting held in Canada).
- If necessary and as an interim solution, outfit workers exposed to high concentrations of asbestos (e.g. where Permissible Exposure Limit is exceeded) with appropriate respirator and personal protective clothing and provide training on use and maintenance;
- Establish detailed plan of action complete with problem areas, proposed solutions, estimated time and costs, milestones, etc.
- Visit other companies, industries to obtain technical solutions, learn from their experiences, etc.
- Implement a dust measurement program to evaluate airborne concentrations of fibre on a regular basis;

P.S. If a company is under pressure from regulatory authorities to demonstrate compliance, a copy of the company's policy statement and action plan could be registered with authorities thereby ensuring adequate time is granted to comply with regulatory requirements.

Step 4

- Implement immediately all dust control measures which require no capital cost (e.g. Repair broken bags; clean all floors and equipment, building structures using wet methods; establish housekeeping schedules to ensure waste does not accumulate from one shift to next).
- Provide appropriate lockers, washrooms and eating facilities;
- Establish training programs for workers to ensure they understand clearly desired work practices and why they are important;
- Undertake another evaluation of airborne fibre concentrations in the plant to determine progress.

Step 5

- Undertake all relatively inexpensive control measures, such as enclosure of conveyor belts and those parts of the production process which can be a source of fibre emissions;
- Purchase or fabricate enclosed debagging or feeding station; isolate this station from other parts of the plant.
- Introduce wet dust control techniques where practical (e.g. cutting and sawing stations);
- Purchase HEPA filtered vacuum devises to clean floors; to decontaminate workers clothing, etc.

Step 6

- Invest in an industrial ventilation system to ensure that all enclosed systems operate under negative pressure and air ventilation capacity is available to all debagging, mixing, grinding and cutting operations;

- Ensure all hoods are properly designed and effective;
- Introduce regular maintenance schedules to ensure proper functioning of the industrial ventilation system;
- Provide training to all workers impacted by the introduction of this technology;
- Undertake another evaluation of airborne fibre concentrations to verify compliance with regulations.

Step 7

- Initiate study of waste production, handling and disposal;
- Implement all process changes necessary to minimize waste production and maximize waste recycling;
- Implement all appropriate procedures to ensure waste is disposed of according to national regulations.

Step 8

- Implement a medical surveillance program of workers with qualified medical doctors;
- Prepare a report to government authorities demonstrating that your company is in compliance with all regulatory requirements.

Step 9

- Implement active research and development program to continue progress in developing low-cost, practical dust control measures with aim of lowering exposure levels to the lowest level practicable;
- Develop product stewardship program targeted towards customers and users of your products;
- Prepare annual report to government (company or industry wide basis);
- Actively participate in national industry association (e.g. by organizing matters on industry wide basis more cost effective access to necessary expertise and services could be available, yielding significant economies to all member companies).

APPENDIX 1 - SAMPLE LETTER EXPLAINING CORPORATE POLICY TO PROVIDE SAFE WORKING ENVIRONMENT

Company policy to provide a safe working environment with the least exposure to chrysotile, and to other potentially hazardous materials, as is reasonably attainable.

We understand that government regulations on this subject are being enforced. We intend to be responsible and put emphasis on this by naming Mr. Josef Burger as coordinator of environment control.

There will be full cooperation between management and the workers. All information will be made available and reports distributed quarterly.

It is our intention to revise our training of workers to incorporate environmental awareness.

Appropriate funds will be allocated to obtain our goals within the next 12 - 24 months.

The President

APPENDIX 2 - JOINT HEALTH AND SAFETY COMMITTEE - Minutes of a Typical Meeting

Date: November 5, 1982

Present: Mr. Josef Burger, coordinator
Miss Amelia Ortiz Management
Mr. Arthur Mitchel

Mr. Mark White
Mr. Anthonio Hawkings Employees
Mr. Georges Hamilton

SUBJECT DISCUSSED

1. HOUSEKEEPING SCHEDULE

Presently accomplished on a regular basis, whenever a worker is idle.

Recommendation:
Establish a regular housekeeping schedule.

2. SPILLS

It is noticed that on many occasions, whenever spills occur (bag damages, overflow process, etc.), no one removes it. It is left there for days.

Recommendation:
Instruction be given to workers and supervisors to clean-up the spills immediately and patch the bags if necessary.

3. FEED CONVEYOR MIXER

This conveyor is not enclosed and is situated in a drafty area. This causes dust to be dissipated over large areas.

Recommendation:
a) Investigate enclosure of conveyor.
b) Investigate minimizing / optimizing draft in the area.

4. MIXER

The chute entering the mixer does not fit properly, causing leakage (dust emission).

Recommendation:
a) Temporary measure would be to tape the opening.
b) Have maintenance modify the chute.

5. SWEEPING

All sweeping is done by brooms without use of water and is an important source of dust in the plant.

Recommendation:
a) Investigate installation of a central vacuum system.
b) Purchase portable vacuum.
c) In the interim, use a wetting or dust suppressor agent.

NEXT MEETING TO BE HELD ON FEBRUARY 8, 1983.

Note: The report is a summary, and not an extensive report, of the discussions which took place. It should state briefly the problems and the various recommendations.

12

Check List for Supervisors / Safety Representatives

12. Check List for Supervisors Safety Representatives

(If not applicable, please do not check "yes" or "no" but leave blank

	Regulations	YES	NO
1.	Has your country ratified ILO Convention 162?	☐	☐
2.	a) Does your country have national asbestos regulatory instruments in place?	☐	☐
	b) Do you have a copy of these regulations on file?	☐	☐
3.	Do you have a joint health & safety committee? (i.e. labour / management)	☐	☐
4.	Does your country have asbestos waste disposal regulations?	☐	☐
5.	Do you put a warning label on your products?	☐	☐
6.	Do you provide a Material Safety Data Sheet with your products?	☐	☐

	Raw Materials - Storage & Distribution	YES	NO
1.	Is the chrysotile fibre packaged in plastic or paper bags when it arrives?	☐	☐
2.	Are transport vehicles cleaned following delivery of the fibre?	☐	☐
3.	Are the bags shipped on pallets and stretch or shrink-wrapped?	☐	☐
4.	Are damaged bags repaired before being stored?	☐	☐
5.	Are chrysotile bags stored tidily away from work area?	☐	☐
6.	Are the empty bags stored in a container still under exhaust ventilation?	☐	☐
7.	Is the fibre taken to working areas in sealed containers or in an enclosed conveyor?	☐	☐

Processing	YES	NO
- Fibre: mixing, moulding, carding, spinning, weaving, etc. **- Products: cutting, grinding, machining, etc.**		
1. Are working methods designed to reduce the amount of dust released?	☐	☐
2. Are fibre products used wet or damp where possible?	☐	☐
3. Are dusty materials kept in closed bins, etc. when not in use?	☐	☐
4. Are machines and processes which produce dust enclosed and kept under negative pressure?	☐	☐
5. Are dusty processes screened off from other areas?	☐	☐
6. Are spillages from machines, etc., quickly contained and removed?	☐	☐
7. Is a dust lamp used to check for dust emissions into the air at machines and processes?	☐	☐
8. Is exhaust ventilation equipment provided to control dust release?	☐	☐
9. Are bins, etc., provided for off-cuts and other waste?	☐	☐

Exhaust Ventilation Equipment	YES	NO
- Enclosures, hoods, etc.		
1. Is the exhaust enclosure as complete as possible?	☐	☐
2. Is the worker, or at least his/her head outside the enclosure?	☐	☐
3. If hoods are used, are they as close as possible to the place where dust is produced?	☐	☐
4. Is all work which should be done in exhausted enclosures being done there?	☐	☐
5. Are hoods and exhaust inlets in enclosures clear and unblocked?	☐	☐
6. Are hoods, ducts, etc., in good condition? (Look out for holes, poor joints, etc.)	☐	☐
7. If air flow or suction gauges are fitted, do they work?	☐	☐
8. Do the gauges have marks for “OK” & “Faulty”?	☐	☐
9. Exhaust systems should be interlocked with the production equipment. Do employees know how and when to turn the exhaust system on?	☐	☐

	Dust Collectors	YES	NO
1.	Is the filter housing in good condition? All doors should fit well and be closed.	☐	☐
2.	Is the bag or bin below the filters well sealed to the discharge chute?	☐	☐
3.	If a suction gauge is fitted, is it working?	☐	☐
4.	Does it indicate whether the suction is OK or not?	☐	☐
5.	If the collector is fixed, is the filtered air ducted to the outside?	☐	☐
6.	If not, is there a dust monitoring device in the return air outlet?	☐	☐

	Inspection and Maintenance	YES	NO
1.	Are the filters shaken or cleaned regularly (at least every day)? This may be automatic or manual.	☐	☐
2.	Is the dust collecting bag changed before it gets too full?	☐	☐
3.	Does the person doing this wear respiratory protective equipment and protective clothing?	☐	☐
4.	Is all the equipment - hoods, enclosures, ducts, collectors, etc., inspected on a regular basis?	☐	☐
5.	Are they thoroughly examined and tested by a competent person on a regular basis?	☐	☐
6.	Does this test include a check with a dust lamp?		
7.	Are reports of the thorough examinations available for you to see?	☐	☐
8.	If defects are noted on reports is a note made of what has been done to correct them?	☐	☐

	Housekeeping	YES	NO
1.	Have cleaning schedules been prepared for all areas, machines, etc., which could be a source of dust or waste?	☐	☐

		YES	NO
2.	Has responsibility for cleaning been assigned to:		
	a) individuals - employees?	☐	☐
	b) specialists - employees?	☐	☐
	c) combination of a) and b)?	☐	☐
3.	Where waste or fibre accumulates are studies undertaken to determine the source in order to eliminate or reduce spillage?	☐	☐
4.	Is the use of dry sweeping prohibited in the plant?	☐	☐
5.	Is the use of compressed air for cleaning prohibited in the plant?	☐	☐
6.	Do you use the following to clean your operation -		
	- fixed vacuum installations?	☐	☐
	- portable HEPA filtered cleaning equipment?	☐	☐
	- mobile floor cleaners?	☐	☐
	- wetting techniques?	☐	☐

	Cleaning - Plant and Buildings	**YES**	**NO**
1.	Is there a cleaning schedule for all buildings, machines, etc.?	☐	☐
2.	Does the schedule state who should do the cleaning and how it should be done?	☐	☐
3.	Is all cleaning done by vacuum or other dustless method?	☐	☐
4.	Is brushing and sweeping of chrysotile waste prohibited?	☐	☐
5.	Are there enough vacuum cleaning outlets or portable vacuum cleaners?	☐	☐
6.	Are the portable cleaners suitable for chrysotile?	☐	☐
7.	Are portable cleaners maintained in good order and cleaned regularly?	☐	☐
8.	Are the buildings and machines etc., clean?	☐	☐

	Chrysotile Waste Handling and Disposal	**YES**	**NO**
1.	Is all hard waste and waste water recycled in your plant?	☐	☐
2.	If not, is it disposed of in appropriate landfills, according to national regulations?	☐	☐

3.	If no national regulations exist, is waste disposed of according to international practices?	☐	☐
4.	Are used chrysotile bags recycled in your plant?	☐	☐
5.	If not, are they disposed of in appropriate landfills?	☐	☐
6.	When collecting small volumes of chrysotile waste is it put in plastic bags or other containers and wetted?	☐	☐
7.	Do workers wear appropriate personal protective equipment when handling chrysotile waste?	☐	☐

	Monitoring of Airborne Fibrous Dust	**YES**	**NO**
1.	Do you know the membrane filter method for asbestos dust measurement?	☐	☐
2.	Do you have a program for monitoring airborne fibre at your plant?	☐	☐
3.	Do you know how to take a personal sample?	☐	☐
	- a static sample?	☐	☐
4.	Do you know the fundamentals of dust sampling strategies?	☐	☐
5.	Do you monitor the dust emission in your plants regularly?	☐	☐
6.	Do you monitor dust levels in the non-occupational environment?	☐	☐
7.	Do you have a quality control program for fibre measurement?	☐	☐

	Respiratory Protective Equipment (RPE)	**YES**	**NO**
1.	Are there clear instructions about when and where it should be used?	☐	☐
2.	Is the RPE approved or recognized by government authorities?	☐	☐
3.	Is it suited for:		
	- the likely dust levels?	☐	☐
	- wear for long periods if necessary?	☐	☐
	- employees with beards and spectacles?	☐	☐
4.	Have employees been trained to use the RPE?	☐	☐

5. Are arrangements made for the equipment to be cleaned and any filters fitted to be changed?	☐	☐
6. Is there an area set aside to store RPE when not in use?	☐	☐
7. Is RPE used when it should be?	☐	☐

Protective Clothing	**YES**	**NO**
1. Are there clear instructions about when it should be worn?	☐	☐
2. Is it changed and cleaned often enough? (In other words, before its gets too dusty.)	☐	☐
3. Do employees know not to take it home?	☐	☐
4. Does it cover employees own clothing and hair?	☐	☐
5. Is a changing room provided?	☐	☐
6. Are there separate lockers for protective clothing and employees own clothes?	☐	☐
7. Are vacuum lines or vacuum cleaners provided in working areas to remove dust from protective clothing?	☐	☐

Food and Drink	**YES**	**NO**
1. Are eating and drinking in working areas prohibited?	☐	☐
2. Is a canteen or rest area provided for eating and drinking?	☐	☐
3. Do people take off their protective clothing before entering the canteen?	☐	☐
4. Is the canteen/rest area kept clean?	☐	☐

Washing/Eating Facilities	**YES**	**NO**
1. Are washing facilities provided at or near the changing rooms?	☐	☐
2. If very dusty work is done, are showers available?	☐	☐

3. Is the washroom kept clean? Are soap and towels available?	☐	☐
4. Do employees wash/shower after taking off their protective clothing and before putting on their own clothes?	☐	☐

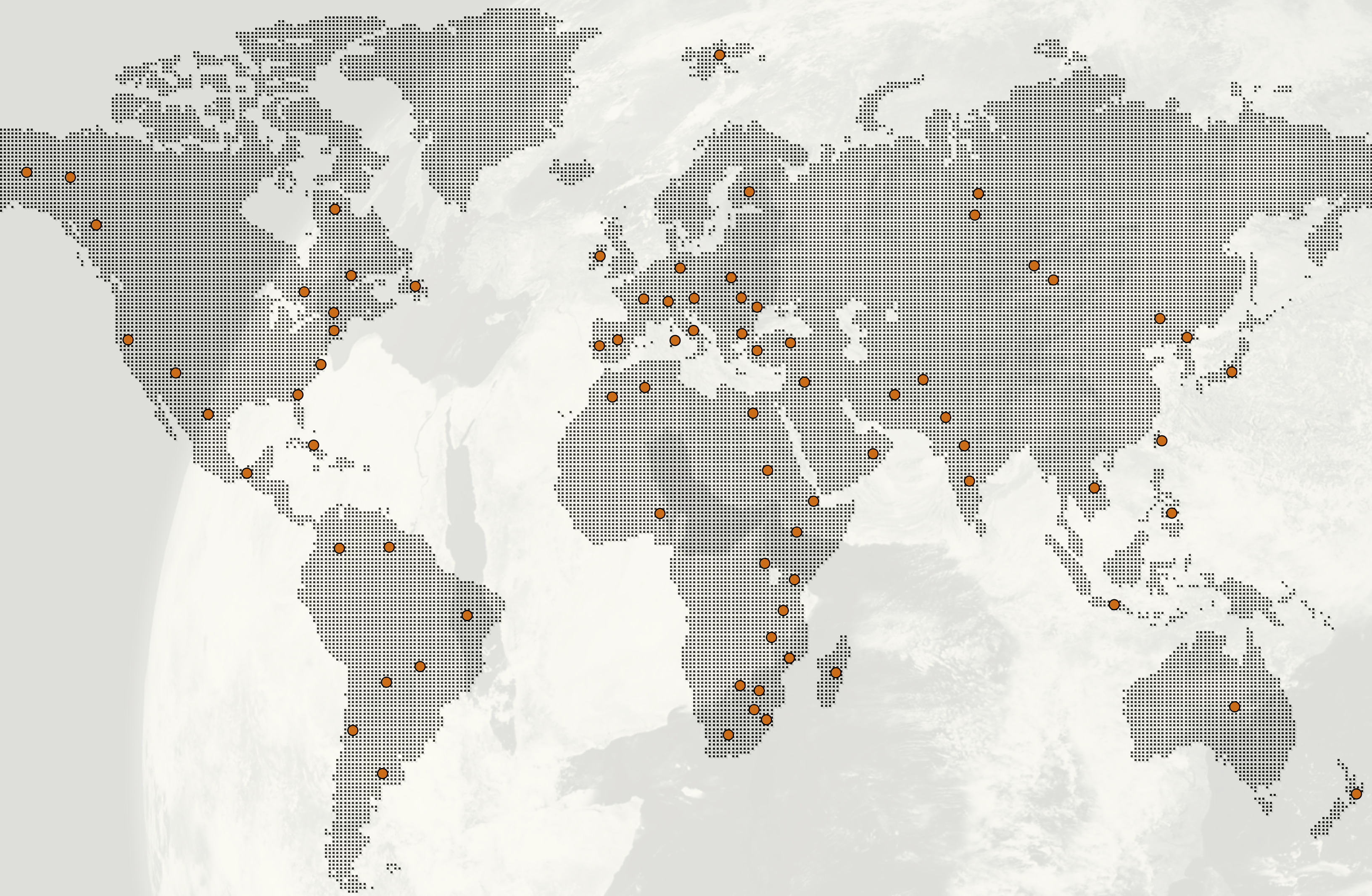
Medical Surveillance	YES	NO
1. Has a health monitoring program been implemented for all those employed by your company?	☐	☐
2. Does the health monitoring program include:		
a) a pre-assignment medical examination?	☐	☐
b) periodic medical examinations?	☐	☐
c) medical examination in and where practicable following cessation of employment?	☐	☐
3. Do only qualified doctors specialized in radiographic analysis perform the medical examinations?	☐	☐
4. Are all medical records kept for at least 40 years?	☐	☐
5. Does the medical doctor actively communicate with the plant manager and keep abreast of information on exposure levels within the plant?	☐	☐
6. Are employees informed for the potential health risks of chrysotile exposure?	☐	☐
7. Are employees aware of the greater risk to health if they smoke and work with chrysotile?	☐	☐
8. Is advice on the dangers of smoking included in induction training of new employees?	☐	☐
9. Are notices/posters prohibiting or discouraging smoking displayed?	☐	☐

Training	YES	NO
1. Is there a program for all employees, from shop floor to senior management?	☐	☐
2. Does it cover both induction training for new employees and refresher courses for existing employees?	☐	☐
3. Is training provided for employees when they change jobs within the company?	☐	☐

4.	Does the program state who is responsible for organizing the training?	☐	☐
5.	Are employees getting the required training?	☐	☐
6.	Is practical instruction on the use of RPE included?	☐	☐
7.	Are records kept of an individual's training?	☐	☐

	Customer/User Outreach Programs	**YES**	**NO**
1.	Are leaflets or pamphlets indicating proper tools, safety procedures and waste disposal information made available to distributors, contractors, users?	☐	☐
2.	Are information seminars or training programs organized for distributors, contractors, architects and engineers on your industry's products, safety procedures, etc.	☐	☐
3.	Is there interaction with customers/users to address and resolve any concern they may have regarding chrysotile containing products?	☐	☐
4.	Are chrysotile products pre-cut or pre-drilled prior to delivery in order to minimize the potential for exposure during installation?	☐	☐

Where is Chrysotile Found?



Chrysotile
Institute