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INSTITUTE OF OCCUPATIONAL AND ENVIRONMENTAL HEALTH MONTREAL CANADA

Asbestos.

On research and regulations in Sweden.

JHM07392

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ASF – the Swedish Work Environment Fund – was established in 1972. The objective of the Fund is to promote a better work environment, thereby to counteract the occurrence of occupational injuries and diseases.

The Fund supports research and development as well as training and information on work environment. Research projects are in progress in a number of areas. Both the chemical and physical environmental problems are studied as well as the psycho-social aspects. The Fund operates essentially along practical lines and the training and information activities are concentrated on gleaning the experience gained during working life.

All employers in Sweden pay a special fee to the Fund, this amounting to a total of Skr 120 million for 1976/77.

Through its board, the activities of the Fund are closely tied to the labour market. Eight of the board members are nominated by the organizations on the labour market. Three members are appointed directly by the Government.

The administration office of ASF reviews grant applications, initiates various projects and ensures that authorized decisions are implemented – in continuing collaboration with the parties concerned.

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Asbestos.

On research and regulations in Sweden.

By Arne Westlin,
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S-100 25 Stockholm, Sweden

Increased knowledge of asbestos hazards has led the responsible authorities in Sweden to ban certain uses of asbestos, and severely restrict others. The TLV has been lowered, and control measures increased. The author summarizes research, but above all the government regulations, in Sweden.



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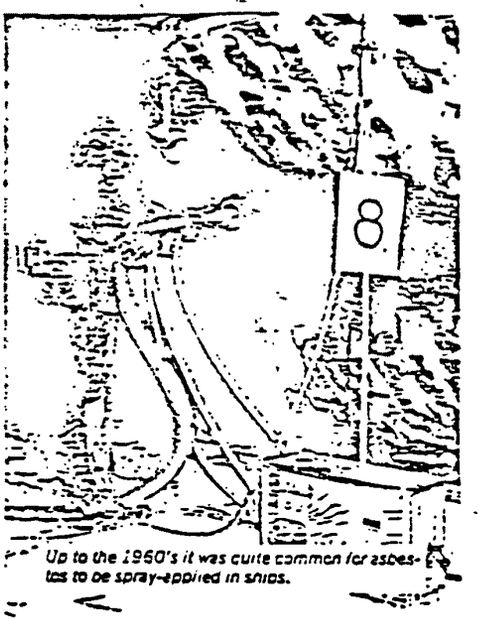
Historical background.

Pre-1960

Asbestos hazards had not generally been noticed in Sweden before Gunnar Ahlborg, in the beginning of the fifties, noted cases of asbestosis at shipyards in the Gothenburg area. It was first in connection with these discoveries that the worth and significance of the in-depth work, involving both scientific research and control measures, which had been done thirty years earlier in England, were appreciated. Starting in the fifties, Swedish occupational medicine has monitored the asbestos question systematically. The international exchange of information regarding asbestos worked less well during the thirties and forties.

1964 asbestos regulations

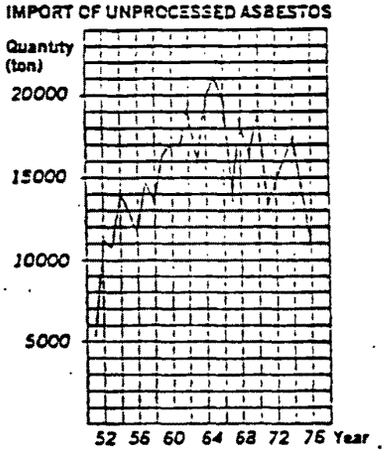
Ahlborg's investigations eventually resulted in the development of Swedish regulations on working with asbestos. They were published in 1964, and were, for their time, quite good. However, compliance was very incomplete, for several reasons. An important point in the regulations was that asbestos should be substituted for when possible. However, without detailed directives from the agency (the National Board of Occupational Safety and Health) centrally, the Labour Inspectorate had a difficult time making demands based on this provision, as long as spraying asbestos for various purposes and heat insulation of large boilers, for instance, were permitted. Furthermore, exposure was hard to determine, because no appropriate sampling methods for measuring asbestos dust levels in the air existed. The medical examination requirements were unwieldy, and were of limited significance from a preventive point of view.



Up to the 1960's it was quite common for asbestos to be spray-applied in ships.

The asbestos project at the Institute for Occupational Medicine.

Nevertheless, as knowledge of asbestos hazards spread, the asbestos question was taken up at a number of occupational safety and health conferences. In 1968 an investigation on asbestos in Sweden was begun at the Institute for Occupational Medicine. By this time, sampling methods had been developed. The investigation's sampling and other field research was largely completed by 1972. The final report was published in 1974, after the data had been analyzed. The investigators used, as the basis for their judgments, samples gathered on a filter and fiber counting in an optical microscope with phase contrast (according to the established method from England).



The investigation showed that the import of unprocessed asbestos into Sweden reached a peak of over 20,000 tons in 1970. 18,000 tons of asbestos products, with varying asbestos content, were also imported. About 90% of the asbestos is chrysotile, 8% anthophyllite, and 2% amosite. (Small quantities of crocidolite were also imported.)

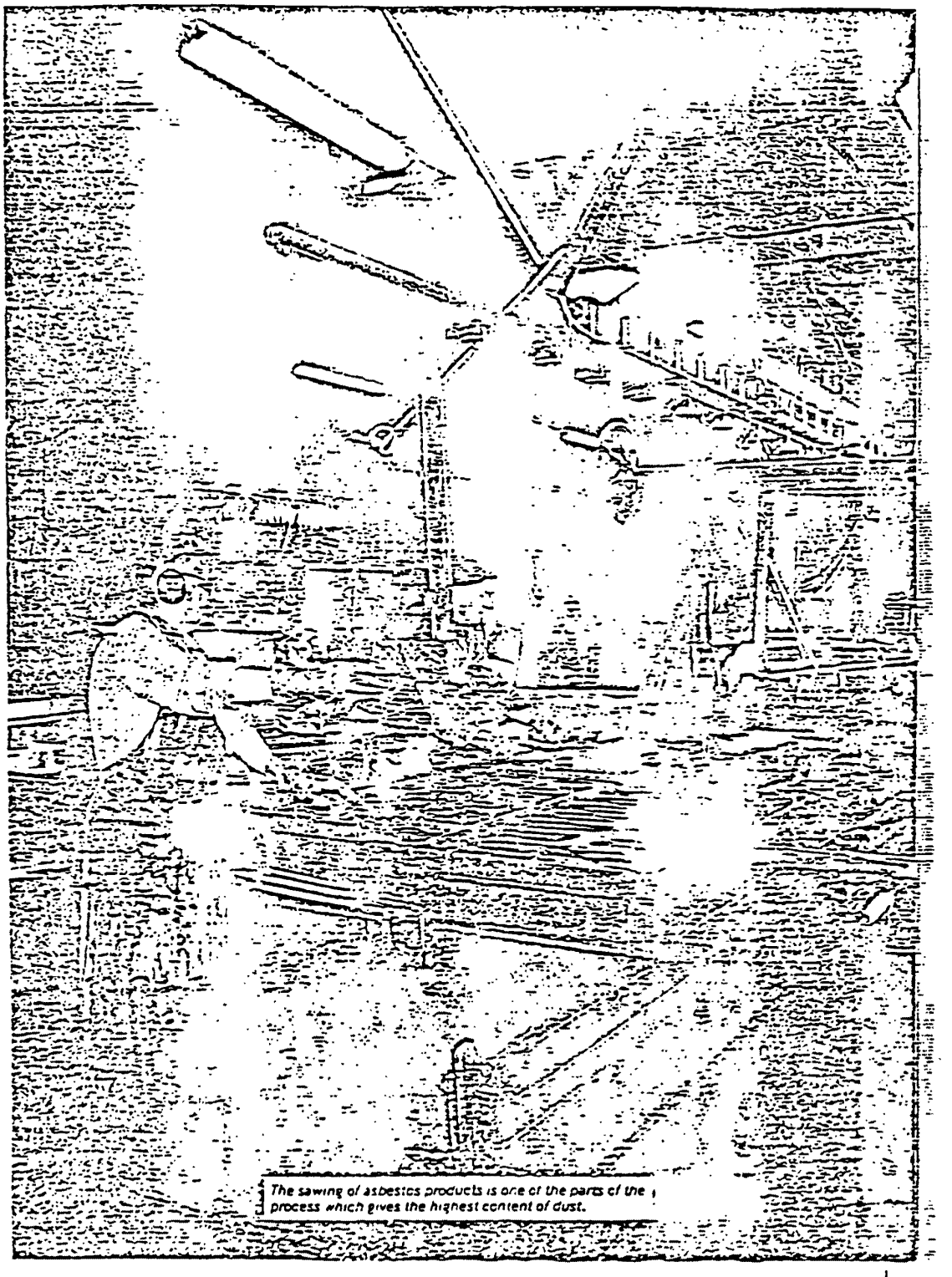
The investigation showed 38 Swedish cases of asbestosis, 4 cases of lung cancer, and 2 cases of mesothelioma associated with asbestos exposure. Epidemiological investigations were begun, and have since been continued by Axel Ahlmark and Anders Englund, among others. Englund showed in 1975 that there were a considerable number of mesothelioma cases at a plant where railroad locomotives were insulated. The epidemiological studies are continuing.

Many different kinds of asbestos work were investigated in the asbestos project, and the levels of dust exposure connected with them are shown in tables 1–3.

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The sawing of asbestos products is one of the parts of the process which gives the highest content of dust.

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Table 1: Processes during the manufacture of asbestos products

Work process	Product Description	# Sampling Locations	Total Dust Levels (mean) mg/m³	Fiber levels (mean) f/cm³
Unloading asbestos	Asbestos fibers	20 (1)	3.2	2.7
Stockroom work	Asbestos fibers, sealing compounds, undersealing compounds, joining compounds	12	3.2	1.1
Drying asbestos	Asbestos fibers	1	1.4	1.4
Charging (incl. surveillance and sometimes drawing off)	Asbestos and various other product components	34	6.7	2.5
Mixing work	Asbestos etc.	17 (1)	2.9	2.1
Surveillance of Hollander mixer	Asbestos etc.	2	0.1	0.1
Surveillance of mixing	Asphalt compounds	1	0.8	0.1
Drawing off	Undersealing and joining compounds	3	3.0	0.6
Crushing of granulated material	PVC and asbestos	2	3.4	0.4
Rolling	PVC, asbestos, paper	6	1.3	0.1
Pressing	Break lining material	3	5.2	2.7
Moulding	Asbestos cement	2	–	0.1
Moulding, cutting, and drying	Asbestos cement	8 (2)	1.8	0.3
Moulding, casting	Plaster moulds w/crocidolite	1	1.2	1.0
Punching	Asbestos cement, asbestos packaging	5	4.5	0.7
Sawing	Asbestos cement	7 (2)	6.2	1.4
Glueing	Asbestos board	2	1.2	0.4
Preparation	Plaster moulds w/crocidolite	1	2.0	2.2
Rewinding	Paper	1	0.7	0.2
Trimming	Asbestos cement	1	–	2.5
Lathing	Asbestos cement	1	2.2	0.2
Picking, inspection	Asbestos cement	1	4.1	1.5
Painting	Asbestos cement	3	–	0.3
Labelling, packaging	Asbestos cement	4	2.3	1.6
Cleaning	–	2	6.3	0.8
Product control, laboratory work	Brake linings, sealing and undersealing compounds	3	1.2	0.3
Transport of granulated material	PVC rugs	1	6.5	0.4
Lunch and change rooms	–	1	0.5	0.4

1. Only a few considered for judgement of total dust levels.
2. Only one sampling location considered for judgement of total dust levels.

Table 1 shows dust levels during the production of a number of various asbestos products. Starting with the removal of unprocessed asbestos from bags, significant exposure may occur. Here it should be noted that during the past several years packaging and handling methods have been improved considerably. In addition, high dust levels were noted during charging into mixers and during mechanical processing, for example. The general impression is that it should be possible to get down to a dust level of 1 fiber/ml air without great difficulties at most fixed workplaces.

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Table 2: Processes during the use of asbestos products.

Work process	Product Description	# Sampling Locations	Total Dust Levels (mean)	Fiber Levels (mean)
Cutting cord, fabric, board, and braided material of asbestos	Asbestos yarn, board, and braided cord	3	0.9	1.1
Flushing	–	2	1.0	0.8
Weaving	Asbestos cloth	2	1.2	0.7
Punching of asbestos cloth	Asbestos cloth	1	0.4	0.4
Sewing asbestos textiles	Asbestos gloves	1	1.5	2.7
Packaging asbestos textiles	Asbestos gloves	1	0.4	0.6
Handling asbestos canvas in connection with welding	Asbestos canvas	2	7.8	0.4
Laying asbestos packing during assemblage	Asbestos braided cord	3	1.4	0.1
Placing in of asbestos board or cloth for hardening of steel	Asbestos cloth and board	8	2.2	0.4
Cleaning bath for hardening steel	Asbestos fibers	1	5.4	14.0
Work in electric-arc furnace	Sinkheads	2	4.2	0.2
Ingot chilling	Sinkheads	5	5.4	0.6
Engineering industry work	Asbestos cement, asbestos yarn	3	2.0	0.1
Glueing	Asbestos cement slabs	2	1.2	1.0
Transport	Asbestos cement slabs	2	7.6	5.2
Drilling installation	Asbestos cement slabs	2 (3)	9.2	0.6
Cutting	Asbestos cement slabs	9 (3)	17.0	4.0
Cutting, drawing piping	Asbestos cement piping	1	16.0	2.5
Laying plastic mats and tiles	Plastic floor mats and tiles	4	3.8	0.2
Putting up glazed tile	Tile glues and joining compounds	4	9.0	1.1
Various processes during renovation of brake linings	Brake linings	12	9.2	1.2
Undersealing compound treatment	Undersealing compounds	1	1.9	0.3

3. Information on time lacking at one sampling location.

Table 3: Processes during insulation work

Work process	Product Description	# Sampling Locations	Total Dust Levels (mean) mg/m³	Fiber Levels (mean) f/cm³
Mixing magnesiacontaining insulation	Magnesia	1	7.7	5.6
Insulating	Magnesia	3	40.0	15.0
Sewing blankets	Asbestos cloth	11	1.1	1.1
Insulation and lining of piping	Asbestos cloth, magnesia	6	–	1.4
Spray insulating	Insulating compounds	3	18.0	8.4
Care of carding machine	Insulating compounds	2	22.0	9.2
Cleaning up	Insulating compounds	4	26.0	6.4
3 days after spray insulating	Insulating compounds	3	7.2	1.2
Lunchroom	–	4	2.2	0.8

Table 2 and 3 shows dust levels during use of asbestos products. It is obvious that there is a great deal of variance depending on whether preventive measures have been taken or not. High levels were noted for textile sewing, cleaning of asbetos devices, transport of asbetos cement slabs, cutting of asbetos cement slabs and pipes, insulation work and the demolition work connected with it, spraying and cleaning.

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Building sites are proclems, among other things from an inspection view-point. Asbestos is often run into when demolishing old buildings.

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New asbestos regulations followed-up and supplemented.

As early as 1972 it appeared desirable to revise the 1964 regulations. The background was information obtained from foreign investigation on asbestos hazards, and the measurement of asbestos exposure in Sweden. The first draft of a revised regulation was discussed with labor and management groups affected in 1973, and after lengthy consideration the new regulations were decided upon in June 1975.

Asbestos shall be replaced by other material

The basic notion in the new asbestos regulations is that asbestos shall be replaced by less hazardous material as soon as this is possible. The idea was that this provision would be followed up with detailed provisions, and this has occurred. The more strict attitude on this point, compared with the 1964 regulations, is based on the now-established view that asbestos is a carcinogen and co-carcinogen. Furthermore, it has been judged desirable in the long run to elimate asbestos, because it can cause, in a fairly high proportion of an exposed population, pleural plaques (thickening of the lining of the lungs), an irreversible tissue change (although one that selcom develops to the stage of causing serious symptoms).

Information and labelling

The regulations require suppliers to inform their customers about the asbestos content in various products – an informational responsibility which also applies to the employer vis-a-vis his employees. It ought to be noted in this regard that the Product Control Council has now classified asbestos as a hazardous substance. Labelling rules, based on the Product Contrel Act, are expected in 1977.

Employers are supposed to notify the National Board Occupational Safety and Health about work using asbestos, and avoid introducing asbestos into new areas of use.

Initial monitoring and subsequent monitoring

The regulations require that employers using asbestos keep exposure under control and sample for atmospheric dust levels. This latter shall occur through both initial monitoring and subsequent monitoring. Initial monitoring shall establish exposure levels for each individual worker. The sampling and analysis method is based on that used by the asbestos investigation.

Assuming that the initial monitoring shows values clearly under the TLV, subsequent monitoring may measure only the total airborne dust levels, and compare them with those in the initial monitoring. At fixed workplaces, such sampling shall occur at least once a year. When asbestos is used at non-fixed workplaces, such as in construction, the need for sampling shall be judged with regard to the regularity of the work. The implication is that new monitoring must occur if conditions producing dust spread change.

Construction difficult to control

It is, however, clear that asbestos could be used in innumerable ways, in construction for instance, if this was allowed. Now the regulations limit such uses if acceptable substitutes exist. To base safety protection in construction on sampling of dust concentrations would require an incredible sampling frequency. This has been judged to be an unrealistic way of attaining satisfactory protection, because working conditions vary a great deal, among other reasons. In such circumstances, compliance with the substantive provisions of the regulations is difficult to achieve. The National Board of Occupational Safety and Health therefore studied certain work methods, and gave permission for those which involved low dust levels to be used under certain conditions. The majority of the previous uses of asbestos in construction have disappeared, either through special directives, or because of the practical difficulties of making sure through monitoring that conditions are acceptable, which has been established as a pre-condition for further use.

The regulations also establish rules for the role of the local safety organization, and for conventional dust control through wet methods, enclosure, exhaust, etc. The spraying of asbestos is forbidden, as well as the use bestos for conventional heat insulation. An exception made for insulation against very high temperatures, such as those in smelters.

Modern rules on medical surveillance

The regulations include modern rules regarding medical surveillance. In addition, the National Board of Health and Welfare, together with the National Board of Occupational Safety and Health, have made special funds available to allow all workers previously exposed to asbestos to receive medical examinations. The regulations point out the danger of joint exposure to asbestos and tobacco. It is therefore important that people exposed to asbestos refrain from smoking. Special informational measures have been taken to that purpose.

Housekeeping

The regulation establishes strict requirements for housekeeping and for personal protective equipment used. Workclothes shall be laundered separately. Asbestos waste is also regarded as a problem; the regulations require its burial.

Demolition

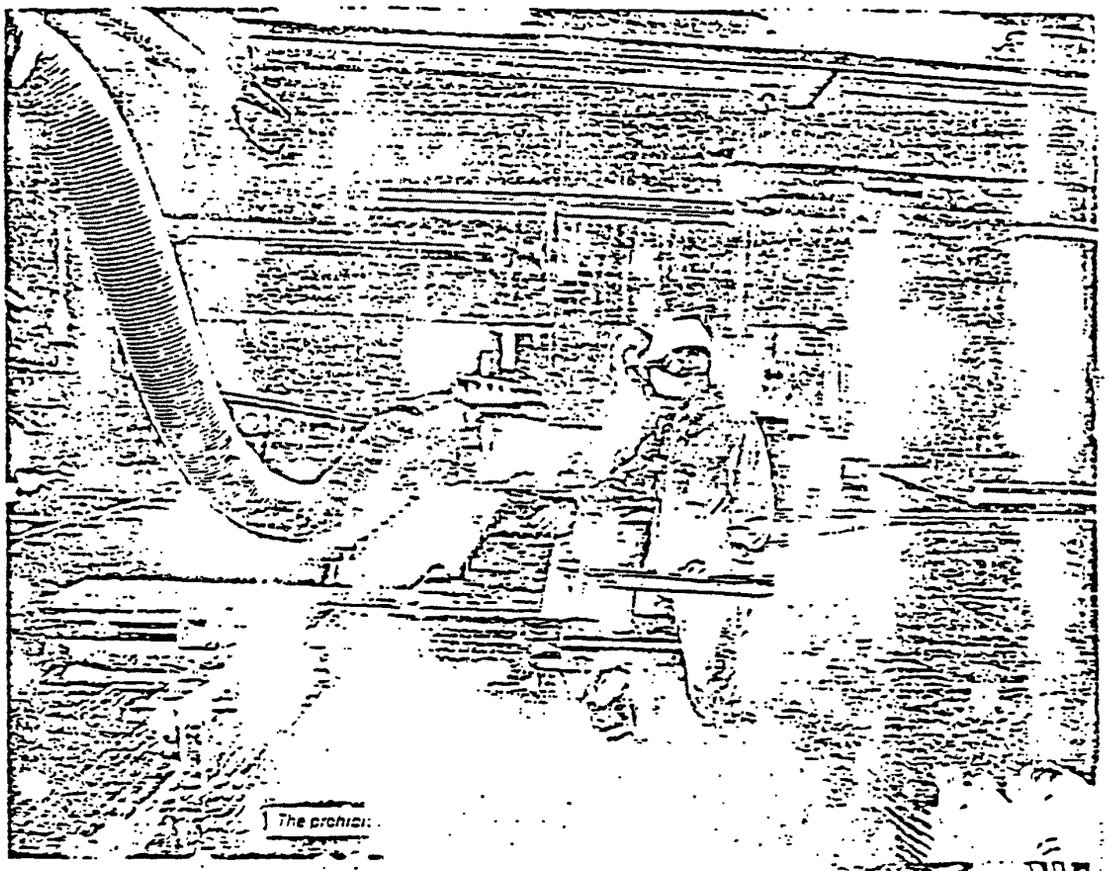
One of the most difficult areas from a control point of view is demolition of asbestos-containing installations. In significant measure, reliance on personal protective equipment is still necessary, and this is an area where further regulations would appear to be necessary. It is also a big practical problem to reach all workplaces where demolition work occurs and where asbestos dust can be generated, for instance, in connection with demolition during replacement of heating units in dwellings.

Crocidolite banned

To move towards a situation where asbestos exposure is slowly reduced to an absolute minimum, supplementary regulations have been issued. The use of crocidolite has been banned, as well as spraying with any type of asbestos-containing material. Asbestos may no longer be used on the back sides of mats, which serves to eliminate exposure during installation and replacement of mats. Asbestos may no longer be used in paint, glue, spackle, joining material, etc. Perfectly satisfactory replacement materials exist in these areas.

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The prohibi...

Controversial ban of asbes...s c...

The use of asbestos cement products has been banned from different dates. This has perhaps been the most controversial of the steps taken. One basis of the ban is that the goal of eliminating asbestos as far as possible is not possible to reconcile with the use of large quantities of asbestos as a building material. Affects on workers have also been noted at factories producing asbestos cement, and when asbestos cement is used on construction sites, exposure occurs again. The preventive measures necessary to deal with exposure were adjudged to be extremely difficult to assure compliance with.

However, permission for continued use of asbestos cement piping has been granted, under the condition that wide-ranging preventive measures are taken. The cutting method for such piping has been changed such that exposure levels have gone down from 5 fiber/ml to 0.1 fiber/ml. (Most cutting now takes place at the factory.) At the same time, the manufacturers are making major efforts to develop replacement material for asbestos as a reinforcing material in this piping.

Finally, the use of asbestos in wall and floor coverings has been banned. This eliminates the not-inconsiderable asbestos exposure which had existed at a number of plastics factories. In addition, informational material will be published on how it is possible to get rid of asbestos in welding and laboratory work, and from personal protective equipment.

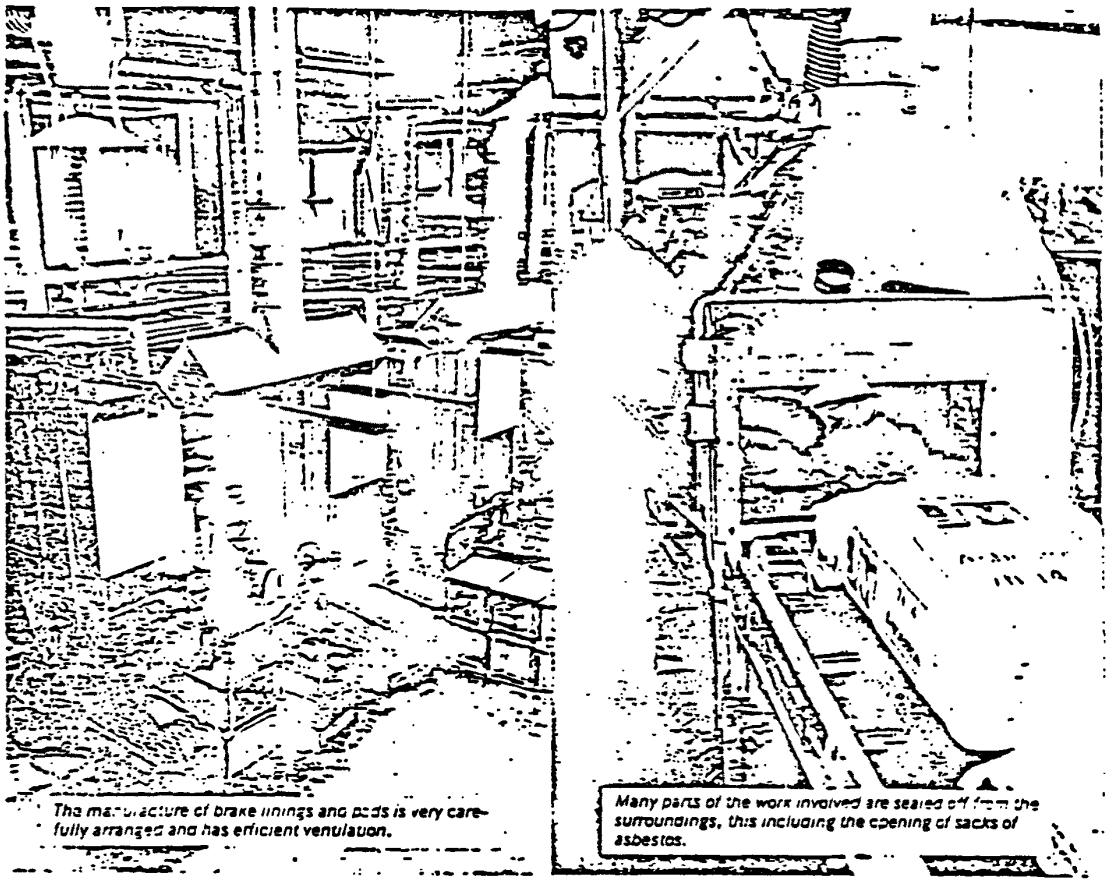


Asbestos is still used in brake friction material.

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The manufacture of brake linings and pads is very carefully arranged and has efficient ventilation.

Many parts of the work involved are sealed off from the surroundings, this including the opening of sacks of asbestos.

Areas where asbestos may be used

The uses of asbestos which for the present are still permitted in Sweden are:

(1) as a friction material in brakes
(2) as a reinforcing material in certain heavy duty packaging material
(3) for insulation against heat, under certain limited conditions
(4) for personal protective equipment (mainly heat-protective), under certain limited conditions
(5) for special purposes, such as chloralkaline electrolysis

The restrictions in the use of asbestos have thus been tightened gradually over a several-year period, which eases the transition for industry to asbestos-free materials.

The dust situation in some of the remaining asbestos plants are shown in tables 4, 5 and 6.

TLV cut in half in 1976

The TLV for asbestos dust was lowered as of July 1, 1976, from 2 fibers/ml of air to 1 fiber. (This corresponds to one million fibers per m³ of air.) The basis was the uncertainty in the dose-response relationship for, to a certain extent, asbestosis, and, even more pertinantly, for cancers such as mesothelioma, even though mesothelioma has been quite rare in Sweden. Dose-response is the relation between the quantity of a hazardous substance a group is exposed to, and the number of individuals in the group who display symptoms. Normally, the higher the dose, the higher the response. One would thus be able to guess, for example, that exposure to 2 fibers/ml of asbestos would result in e.g. twice as many cases of asbestosis among a large group of exposed individuals as 1 fiber/ml. Similarly, one speaks of dose-effect, implying that an individual's risk increases with the dose. Dose-response and dose-effect are normally displayed diagrammatically, and the assumption for many substances is usually that both response and effect cease if the dose is sufficiently small (no-effect dose). In order to be careful, one frequently makes the assumption for carcinogens that even the smallest dose increases, even if minutely, the risk.

According to information from the Norwegian occupational safety and health authorities (1977), approximately 1–3% of an exposed population shows a response, in the form of beginning cases of asbestosis, at dose levels of 2 fibers/ml. Further, pleural plaques, which occur quite commonly, [illegible]y can be initiated by very low levels of asbestos exposure. Risks for asbestos-induced pleurisy have also been noted. At the same time, 1 fiber/ml has appeared to be a realistic (that is, attainable) value for the uses of asbestos which for the present remain in Sweden. Protection is thus being built on a combination of low exposure levels and a small exposed group.

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Table 4: Dust levels at Factory 1

	fiber/ml air: ≤ 0.1	0.1–0.5	0.5–1	1–2	>2
December 1975:					
Stationary sampling locations	6	–	–	–	–
Personal dust collectors	25	5	–	–	–
November 1976:					
Stationary sampling locations	20	4	1*	1*	6*
Personal dust collectors	22	47	14	2	5

* non-permanent workplace (filter house)

	Dust levels mg/m³ (approximate)
December 1975 stationary sample:	0.2
personal sample:	1.5
November 1976 stationary sample:	0.4
personal sample:	0.2

(December 1975 operation working at less than 50% of capacity. November 1976 full capacity).

Analysis of typical workplace with a sample showing high fiber levels.

Sampling time, hours	Fibers/ml in sample	timeweighted average
3.5	0.2	
3.15	0.1	
2.5	0.3	
2.3	0.3	
1.85	2.3	0.4 fibers/ml
3.5	0.2	
3.0	0.2	
3.25	0.3	
2.0	0.2	
2.5	0.2	

Table 5: Dust Levels at Factory 2

Work process	As of Nov. 1972 mg/m³	fibers/ml	As of Febr.-1976 mg/m³	fibers/ml
Unloading asbestos	10.5	1.3	2.7	0.5
Storing asbestos	0.3–5.8	0.1–1.3	0.3	<0.1
Mechanical handling	5.8	1.2	2.9	1.3
Forming	2.5	0.3	1.3	0.3
Mechanical processing	3.0	0.2	1.5	0.5

Table 6: Dust levels at Factory 3.

Work process	As of 1969 mg/m³	fibers/ml	As of Dec. 1975 mg/m³	fibers/ml
Unloading and storing	–	low	–	low
Mechanical handling and forming	~1.5	0.5	1.0–2.4	0.1
Mechanical processing	4.6	1.1	0.5–2.7	0.3–1.1
Assemblage	~1.5	0.5	2	0.1–0.4
Cleaning	–	–	2	0.1–0.2

Dust levels at the three remaining plants using asbestos must be regarded as satisfactory. Ongoing efforts are being made to improve air quality conditions further.
At the same time, it must be pointed out that constant attention and checking, cleaning and maintenance of the ventilation system, etc. are necessary to maintain the present situation.

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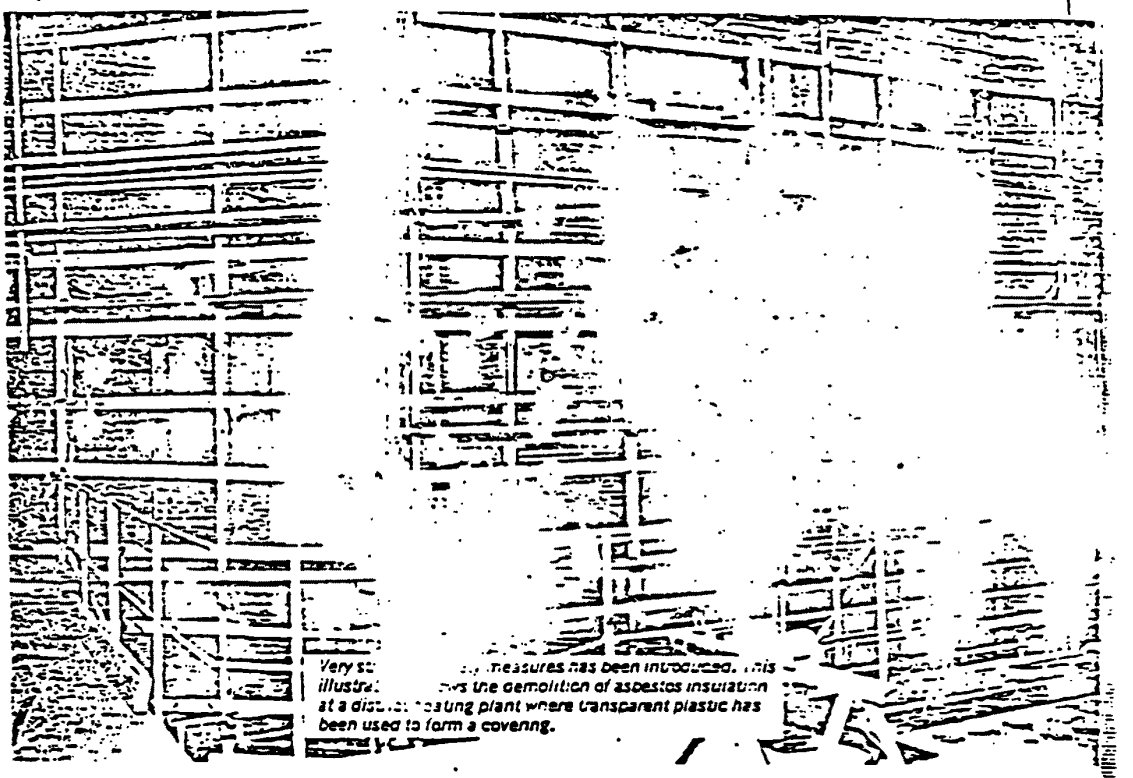
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Very st... measures has been introduced. This illustra... ...ws the demolition of asbestos insulation at a distil... ...sating plant where transparent plastic has been used to form a covering.

Difficulti... control increase the need for ... measures

The restrictio... e use of asbestos which have been introduced ... ...n may justifiably be called very strict. This is in co... ...idence with the intentions apparent in the parliam... ...s treatment of the asbestos matter. Given our knowled...e about the relationship between dose and risk of illness, reliance on conventional protective measures is insufficient. If unlimited use of asbestos was allowed, it would in practice be impossible to assure that the proper protection was provided at all times and at all workplaces. This is especially the case because, in such circumstances, asbestos would be used at many temporary workplaces. The conventional protective measures we are talking about are ones like handling asbestos in special rooms if possible, processing asbestos in closed systems, ventilating asbestos dust, and so forth. It is hard to check compliance with this type of measure, and this increases the need for other types of preventive measures.

Replacement material

Replacement materials for asbestos are primarily glass fiber and rockwool products. There are also many replacement materials for specific uses (expanded mica for heat insulation, for instance, or ceramic fibers for high temperatures). It is clearly a problem to determine the relative harmfulness of all the conceivable substitutes compared to asbestos. The general position of the National Board of Occupational Safety and Health has been that most materials which do not contain a specific highly toxic component, or generate large quantities of dangerous dust, should be preferable to asbestos. The Board is participating in the in-depth work going on to determine the hazards involved with various types of inorganic synthetic fibers.

Arne Westlin

Further reading.

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JHM 07403

CRMC-Motley1000-Subj-002586



The requirements made on personal protective equipment are also very strict.

JHM 07404

CRMC-Motley1000-Subj-002587

This brochure is one of five reports published by ASF – the Swedish Work Environment Fund – in connection with the International Symposium on the Control of Air Pollution in the Working Environment. The symposium is arranged by the Fund and ILO – the International Labour Office – in Stockholm, September 1977. The reports give a summary of current research and the problems that remain to be solved. These publications are available in both Swedish and English language editions.

- Metals. Health hazards of industrial metals – a selective survey.
- Welding. Research and new technical solutions for a better work environment in the welding industry.
- Surface treatment. Research and new technical solutions for a better work environment.
- Asbestos. On research and regulations in Sweden.
- Silicosis. On research and regulations in Sweden.

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