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Exposure of insulation workers to asbestos dust

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INTRODUCTION

Asbestosis was first described as an occupational disease among insulating workers by Ellman (5) in 1934. Since this initial report some hundred other cases of »lagger's pneumoconiosis» have been described, and this kind of occupation has been recognized as highly hazardous in industrialized countries all over the world. It has also been shown that there is a highly increased risk of lung cancer occurring in persons exposed to dusts containing asbestos in insulation work (7, 9).

The first known case of pulmonary asbestosis among insulation workers in Finland was discovered as early as 1938 (1). The register of occupational diseases at the Institute of Occupational Health in Helsinki now includes a total of 56 cases of insulation workers with pneumoconiosis.

In order to obtain more information about the prevalence of asbestosis among insulators, the Institute of Occupational Health carried out a field investigation in 1962—1963 which included all actively working laggers in the three largest Finnish cities. This investigation was continued after an interval of a few years. The total number of workers examined during the period 1962 through 1968 was 452, nearly three-fourths of all insulators still working in this country. In spite of these examinations, no reliable, current data regarding the true incidence of lagger's pneumoconiosis are available, and even less is known concerning the morbidity of former years. Work producing the hazardous dust has been performed in this country for several decades. According to the newly revised law relating to the safety of working environments, however, all workers must nowadays submit to a periodical examination at least once every 3 years.

It is obvious that sufficient attention has not yet been paid to the improvement of working conditions. Data on the situation in the varying kinds of insulating work are very scanty since neither systematic checks are made of dust concentrations nor is regular control of the use of personal protective masks performed.

To obtain more knowledge on the environmental conditions of insulating work, the Institute of Occupational Health, in connection with an intensified investigation of asbestos hazards in general, recently started a program of measuring dust levels that includes insulating work places.

INSULATION WORKERS SUFFERING FROM ASBESTOSIS

The number of cases of asbestosis diagnosed among insulators before and including 1968 have been given in table 1. They have been arranged according to the year of diagnosis.

Table 1. The number of diagnosed cases of asbestosis among insulators in the years 1938—1968.

1938	1 case	1960	5 cases
—		1961	2 »
1946	2 cases	1962	5 »
—		1963	3 »
1952	1 case	1964	3 »
1953	1 »	1965	3 »
—		1966	5 »
1957	2 cases	1967	4 »
1958	5 »	1968	11 »
1959	3 »		
		Total	56 cases

The duration of exposure to dust (working time as an insulator) was known in 46 cases

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and ranged from 10 to 40 years at the time of diagnosis. The distribution has been shown in table 2 according to the length of exposure, using 5-year groups.

Table 2. Distribution of insulation workers with asbestosis according to the length of exposure.

Exposure time in years	Number of affected persons
≤10	0
11—15	4
16—20	9
21—25	9
26—30	13
>30	12
Unknown	9
	Total 56

The main criterion for accepting a case as asbestosis was the presence of typical radiological manifestations in the lungs, such as interstitial or focal fibrosis, especially in the middle or lower areas. This was not regarded as sufficient for diagnosis, however, unless it was clearly proved that the patient had a sufficiently long duration of exposure. Pleural calcifications or thickenings as the only noticeable radiological findings, without a typical occupational history, were not enough to classify the case as anything but suspected asbestosis.

The frequency of pleural calcifications or radiologically visible pleural thickenings has been shown in table 3. Some cases have been excluded because of the uneven technical standard of earlier radiographs, and the group presented in the table consists only of the 41 cases diagnosed from 1960 through 1968.

Table 3. The frequency of radiologically visible pleural thickenings or calcifications in all cases diagnosed in 1960—1968.

Unilateral	Bilateral	None	
9	18	14	Total 41

TYPE OF INSULATION WORK AND MATERIALS USED WHICH CONTAIN ASBESTOS

The most common type of insulation work in Finland is the thermal insulation of pipes that is done manually, whereas asbestos spraying is rarely used in the building industry. Previously, insulating material was an asbestos compound consisting of clay, diatomite, and asbestos. Nowadays, in addition to the old compound, mineral wool and glass wool, neither of which contains asbestos, are used for the same purpose. The work of a lagger is very dusty, particularly the repair and demolition work that is done in cramped and poorly ventilated places. Protective masks were earlier rarely used, and their use is still often impossible because of cramped working spaces.

Many different brands of asbestos materials are manufactured for the thermal insulation of pipes. The lining insulation materials used in pipe insulation work mainly consist of either diatomite and clay or vermiculite diatomite and clay, with only some per cent being amosite asbestos. Bentonite and woodmeal are used as the filler. Surface insulation material contains 20 to 35 % asbestos (antophyllite or chrysotile and a slight amount of amosite) and Portland cement or clay. The asbestos insulation material most commonly used in Finland consists of 70 to 80 % diatomite, 10 to 15 % clay, 5 to 7 % asbestos (chrysotile and amosite), and some per cent vermiculite, woodmeal and gypsum.

In the shipbuilding industry sprayed asbestos insulation is used for ceilings and bulkheads. Even if the material is moistened it causes a lot of dust. Only some years ago the shipyards in Finland started to use noncombustible wallboard made of asbestos and calcium silicate. The insides of cabins and corridors, as well as walls and ceilings are lined with the board, a protective measure against fire that is demanded by insurance companies. The board is cut into the required sizes by circular or band saws, which produce plenty of dust. These calcium silicate-asbestos boards contain about 30 % asbestos.

ASBESTOS DUST MEASUREMENTS AND STANDARDS

In recent years regular dust measurements have been made in the Finnish asbestos industry, but very rarely at places where insulation work is being done or where other asbestos products are being used.

Methods

Particle counting or gravimetric methods have been used for the dust measurements.

The samples for counting asbestos dust particles were earlier taken with a midget impinger only (ethyl alcohol being the sampling medium). They were examined using a light field microscope with a magnification of 300 x. This year dust samples have also been collected on membrane filters and counted by phase contrast at a magnification of 500 x. All particle concentrations shown on this paper are still counted by the impinger light-field count technique. The following four ways of counting asbestos dust are used:

1) Counting all particles (fibers and grains smaller than 5 microns ($<5\,\mu m$)
2) Counting all grains larger than 5 microns
3) Counting only fibers as large as 5 to 10 microns
4) Counting fibers longer than 10 microns

All particles whose length is at least three times the width are considered fibers.

For measuring the total mass concentration of the dust, long-period samples on membrane filters have been taken either from stationary points (Millipore Filter, Type AAWP 037) or from the breathing zone of the workers.

Permissible dust concentrations

According to American findings concerning asbestos dust *particle concentration*, a threshold limit of 175 particles per cubic centimeter (= 5 mppcf) has been recommended as a ceiling value below which all concentrations should fluctuate (2), and a threshold limit of 70 particles per cubic centimeter (= 2 mppcf) has been recommended as a time-weighted average concentration as counted by the impinger light-field count technique (3). The same values have also been recommended in Finland. In the U.S.A. there has also been a tendency to recommend a threshold limit of 12 fibers per milliliter for fibers longer than 5 microns, as determined by the membrane filter method, at least at a phase contrast magnification of 430 x (2).

Assuming there to be a 1 % risk of contracting asbestosis during a 50-year working exposure, the Committee on Hygiene Standards of the British Occupational Hygiene Society has recommended the following criteria for limiting exposure to chrysotile asbestos (4):

Dust category	*Chrysotile concentration** Fibers/ml**
Negligible	<0.5
Low	0.5—2
Medium	2—10
High	>10

* Average during a 3-month period
** Greater than $5\,\mu m$ in length

From these criteria a limit of 100 fibers per milliliter-years was proposed, hence a limit of 2 fibers per milliliter averaged over a 50-year period. The same values should also be recommended for all other forms of asbestos, with the exception of crocidolite (8).

We have not yet established any recommendations for asbestos dust *mass concentrations* in Finland, but, according to simultaneous, comparable dust measurements in the plants manufacturing asbestos products, the mass concentration of asbestos dust equivalent to 70 particles per cubic centimeter would be of the order of from 0.7 to 1.0 mg/m³, and the corresponding equivalent to 175 particles per cubic centimeter would be from about 1.75 to 2.5 mg/m³. In the Soviet Union the threshold limit value for dust containing more than 10 % asbestos is 2 mg/m³, and the same value is used in Czechoslovakia.

Recently it has been reported (4) that in the Federal Republic of Germany the following values are used as a temporary measure for the assessment of asbestos dust mass concentrations:

- 2 mg/m³, if the asbestos content of processed raw material is below 10 %
- 1.5 mg/m³, if the asbestos content is between 10 and 50 %
- 1.0 mg/m³, if the asbestos content is higher than 50 %

RESULTS OF DUST MEASUREMENTS

The dust concentrations measured in the air of the breathing zone of workers during the *manufacturing of insulation materials* has been given in table 4. The table shows that the measured dust concentrations exceed the recommendations many times, and, therefore, the use of protective masks has been recommended for the workers until it is possible to employ a more effective method of dust control. Even if only 5.2 % to 8.9 % of all the dust particles in the air are asbestos fibers, the concentration is still very high.

Dust concentrations measured during the insulation of ordinary pipe with asbestos insulation material *in the building industry* have been shown in table 5. The measured concentrations in this work were approximately equal to those in the manufacturing of insulation material and are thus very high. The insulation workers, with the exception of one, did not use protective masks because they thought it impossible in the cramped working

Table 4. Asbestos dust concentrations measured during the manufacturing of insulation material.

Survey No.	Operation	Particles per cubic centimeter				
		Particles <5 μm	Grains >5 μm	Fibers >5 μm	Fibers >10 μm	Total
1	Loading of elevator (with bags)	439	67	18	10	534
	—•—	652	63	40	16	771
	Filling of drum mixer	751	61	44	24	880
	Bagging machines	1,270	175	122	19	1,586
2	Loading of elevator	250	36	24	6	316
	Bagging machine	856	128	76	16	1,076
3	Loading of elevator	478	146	6	5	635
	Bagging machine	616	139	77	29	861

Table 5. Asbestos dust concentrations in insulation work in the building industry.

Operation	Measured dust concentrations Particles per cubic centimeter					
	Particles <5 μm	Grains >5 μm	Fibers >5 μm	Fibers >10 μm	Total	Mass concentration mg/m^3
Mixing of the insulation material	660	195	53	3	911	—
Insulation of pipe, breathing zone	1,380	280	60	26	1,746	20.0
Insulation of pipe, general air	1,090	265	92	14	1,461	—
Insulation of pipe, breathing zone	840	160	61	11	1,072	20.0
Insulation of pipe, general air	710	134	34	12	990	—

Table 6. Asbestos dust concentrations measured during the sawing of asbestos-calcium silicate boards in a shipyard (Navilite boards).

Place of measurement	Measured dust concentrations Particles per cubic centimeter					
	Particles <5 μm	Grains >5 μm	Fibers >5 μm	Fibers >10 μm	Total	Mass concentrations mg/m^3
Board feeder's breathing zone	1,317	141	86	45	1,589	17.1
Receiver of sawn boards, breathing zone	2,740	308	148	190	3,386	—
—•—	2,950	131	220	100	3,401	20.3
—•—	1,995	197	163	154	2,509	—
General air, 10 m from saw	1,046	82	51	20	1,199	—

spaces. Thus they were obviously exposed to very dangerous asbestos concentrations.

Personal, long-period, gravimetric dust samples were also taken from the breathing zone of one worker. Membrane filter monitors were connected to a personal sampler pump worn by a worker who had the filter monitor attached to his collar. The measured mass concentrations were very high.

In the *shipbuilding industry* asbestos dust measurements have been made only once. The results of these measurements have been given in table 6. Also in this work dust samples were taken with portable personal sampler pumps, the membrane filter being attached near the breathing zone. All measured dust concentrations were very high and indicated an obvious risk of asbestosis. Due to the dust measurements the shipyard has undertaken more effective dust protection measures. A remeasurement of dust levels will determine to what degree these preventive measures have succeeded.

CONCLUSIONS

The numerous incidents in recent years of verified asbestosis among insulation workers in the construction and shipbuilding industries indicate that previously there was little knowledge about the health risks connected with this work or that such knowledge was simply ignored.

The dust measurements of the last few years also clearly indicate that obviously a large number of workers are still exposed to dangerous asbestos dust concentrations. Thus it is extremely important to examine, on a larger scale than previously, the working conditions of workers using asbestos materials in the building industry and in shipyards and to improve the medical and technical protection of such workers against the risk of asbestosis occurring.

REFERENCES

1. *Ahlman, K.* Asbestosis among insulation workers in Finland. International congress on occupational health proceedings, Vienna, (p. 19—24) 1966.
2. *American conference of governmental industrial hygienists* (St. Louis, Mo.). Threshold limit values of airborne contaminants for 1968. (May 13) 1968.
3. *American conference of governmental industrial hygienists* (St. Louis, Mo.). Supplemental documentation of threshold limit values, asbestos — all forms. Transactions of the thirtieth annual meeting of the American conference of governmental industrial hygienists (p. 188—191) 1968.
4. *Committee on hygiene standards of the British occupational hygiene society.* Hygiene standards for chrysotile asbestos dust. Ann. occup. hyg. 11:47—69, 1968.
5. *Ellman, P.* Pneumoconiosis: Part III. Pulmonary asbestosis. Brit. j. radiol. 7:281, 1934.
6. *Hasenclever, D.* and *Schütz, A.* Measurement of dust containing asbestos for assessing asbestos hazards. International conference of pneumoconiosis, Johannesburg, April 23—May 2, (p. 301—303) 1969.
7. *Hinson, K. F. W.* Cancer of lungs and other diseases after exposure to asbestos dust. Brit. j. dis. chest 59:121, 1965.
8. *Holmes, S.* Personal communication, 1969.
9. *Selikoff, I. J., Churg, J.* and *Hammond, E. C.* Asbestos exposure and neoplasia. J.a.m.a. 188:22, 1964.