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CONTROL OF ASBESTOS FIBER EMISSIONS

FROM INDUSTRIAL AND COMMERCIAL SOURCES

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Asbestos has been termed the magic mineral and it is truly just that. In the United States alone there are over 800,000 tons used in thousands of different products. These products run the gamut from every day floor tile and brake linings to the more exotic heat shields for moon rockets. Asbestos, like almost all products used in our modern technology can, if improperly handled, produce health hazards for those people occupationally exposed to it.

Asbestos related diseases have been known in occupational groups for some years. The first case of asbestosis (extensive pulmonary fibrosis) was reported by Montague Murray[1] in 1907, although it wasn't until 1930 in Great Britain that Merewether and Price[2] first identified asbestosis as a major health hazard for workers exposed to the dust. Subsequent studies dealt primarily with factory populations. More recently, investigators have studied workers who handled asbestos products outside the factory environment.

Asbestos related disease among the shipyard workers was well documented by Harries[3] and others. Selikoff[4-7] and coworkers have studied asbestos insulation applicators in the construction trade. His work not only confirmed asbestosis findings but pointed to an increase in incidence of bronchogenic cancer and pleural and peritoneal mesothelioma.

These reports dealt with occupational exposure - either factory or among certain segments of the construction industry. During the 1950's investigators began studies of selected non-occupational population groups and their relationship to asbestos related neoplasms. Kiviluoto[8] and Laamanen[9] of Finland, Thomson[10] and Wagner[11] in South Africa, Newhouse and Thomson[12] in London as well as investigators in the United States have published reports suggesting a higher than normal rate of certain diseases among people living in the vicinity of some asbestos factories and mines.

While much speculative material has been published on the potential health hazards of asbestos in the ambient air to the general public -- those people not occupationally exposed to asbestos, and not living in the vicinity of asbestos plants and mines -- the limited factual data collected leaves us with many unanswered questions. What is the present level of asbestos fiber in ambient air? What are the large sources of fiber emissions into the air? What are safe limits of asbestos fiber in ambient air? When we speak of asbestos fiber as a causal agent in neoplasms of what size fiber are we speaking? Are there any [illegible] involved?

Studies are currently underway seeking answers to these questions. Some much needed information will not be available for several years. In the meantime, it would be advisable as a precautionary measure to take steps to reduce the amount of asbestos fiber that is permitted to enter the ambient air.

There are five major sources from which asbestos fiber enters the air - (1) mining (2) milling (3) manufacturing (4) certain segments of the construction industry and (5) naturally occurring sources. The first four are created by modern man's technology and the last by normally occurring changes in our environment.

First let us consider mining, and milling. Since most of the asbestos mined in North America is taken from open pit mines, the problem of controlling fiber emissions into the ambient air is difficult to solve. Listed in the charts below are the chief operations in both the mines and mills and the chief methods of control currently in use in North America.

MINING

OPEN PIT

Drilling	Small bag collectors Water
Blasting	No known method for efficiently controlling emissions to ambient air
Material Handling Shoveling	Filtered air cab (protects worker only) The use of water to soak piles of ore is sometimes used
Material Handling Handling	Filtered air cab (protects worker only) Covered load - canvas
Roadways	Road stabilization program - oil chemical water
Waste disposal	Tailings are covered with earth - reforestation

Control methods in certain mining operations leave much to be desired. Methods for controlling emissions from blasting are virtually non-existent. Dust controls in material handling still need considerable development.

MILLING

Crushing	Bag Filter* - a cyclone may be used as a primary collector
Ore drying	Bag Filter - a cyclone may be used as a primary collector
Milling	Bag Filter
Classification Air Separation	Bag Filter
Packaging	Bag Filter
Solid waste disposal	Tailings are covered with earth reforestation
	* Filters usually enclosed in a negative pressure bag house.

The technology to effectively control asbestos milling emissions is on the shelf. Bag filters with an efficiency in excess of 99% are readily available. Recent discussions regarding the relationship of bag house efficiency and fiber size have pointed up the need for more data from the medical community regarding the biologic activity of the submicron asbestos fibers.

Much of the emissions of asbestos fiber from manufacturing operations result from efforts to improve working conditions within the plant. The material collected from the work place must be disposed of in such a way as to prevent its escape to the ambient air.

The chart below lists some major operations which are common to production lines using asbestos.

MANUFACTURING

Asbestos cement products - floor tile - friction material, plastics, etc.

Dry and/or Wet Mix	Bag opening Bag dumping Bag disposal	Enclosure or hood to bag house. Wet scrubbers are also used for dry mix
Pressing - Moulding - Forming -	Wet stock Wet furnish Wet furnish	No dust Slurry - no dust Slurry - no dust
Drying & Curing	Little or no dust generated during operation	
Finishing	cutting grinding sawing, planing routing	Enclosure or hood - to bag house Primary cyclone may be used
Packaging & Shipping	Bagging Boxing	Pickup point to bag house
Warehousing	Raw material Finish product	Vacuum sweeper to disposable bag

With few exceptions the negative pressure bag house is perhaps the unit of choice for asbestos fiber control in a manufacturing process. A high efficiency (99%+) is necessary for adequate control.

MANUFACTURING

Asbestos Textile

Carding Willowing	Enclosures, hoods or pick-ups vented to bag house
Weaving Spinning Twisting	Certain operations may be performed while the fiber is moist thereby reducing dust.
Material handling Bag opening Bag emptying Bag disposal Bins Bobbins Spools	Enclosure or hood to bag house

In textile manufacturing emission control is slightly different in that much of the dust can be supressed by use of water in the weaving, twisting, and spinning phases. Asbestos textile processing is still the most troublesome of the manufacturing operations involving asbestos.

CONSTRUCTION USES

The bulk of the asbestos used in the world is consumed by the construction industry. Steam pipes and boilers are insulated with a calcium silicate material containing 5-15% asbestos fiber. An asbestos fiber containing cement is used to plaster boilers, breechings and reactor vessels in chemical plants and oil refineries. Asbestos containing board is used aboard ship for fireproof bulkheads.

In spite of the fact that the construction trades use many dozens of asbestos containing products, the use of most of these products (those with asbestos "locked-in" by plastic or cement) contributes very little to ambient air pollution.

Selikoff[6] has pointed out that use of asbestos containing material creates a severe health hazard to the insulation worker. This occupational hazard is largely due to the fact that the material becomes airborne, in an enclosed area. On the other hand, this very fact works against asbestos fiber entering the ambient air. Often, when an attempt is made to reduce asbestos health hazards in the work place, such as air removal from a ship's compartment or an insulation fabrication shop, the dust is not collected but released into the ambient air. Any time asbestos containing material is removed from a work place, extreme care should be taken to prevent its escape into ambient air. Bag house collectors are available which collect dust from fabrication shop machinery and deposit it in a disposable plastic bag. Perhaps one of the greatest sources of asbestos fiber emissions to ambient air from certain construction applications arises from poor housekeeping on construction sites. Sawdust and scrap from the cutting and fitting of calcium silicate block and pipe covering are scattered about building sites. The material is then ground underfoot or truck tires and carried away.

A small portion eventually becomes airborne. Control methods for this type of emission demands care, common sense and good housekeeping practices rather than sophisticated dust collecting equipment.

Construction

Asbestos containing building materials

Calcium Silicate Products Pipe Covering Block	Cutting with hand saw Cutting with band saw table saw saber saw	No control device available for the hand saw. Bag collectors are available for fabrication shop or on site use.
Asbestos Cement	Dry mixing in pail quantities Dry mixing in tub quantities	Asbestos cement now marketed in plastic bags suitable for use as a mixing container.
Asbestos Cement Products (Tightly bound) pipe board	Cutting, with bandsaw Rotary saw	Bag collectors are available both types of saw.

The above operations are customarily performed in confined areas. The air pollution usually arises from efforts to reduce dust in the work place.

Solid waste disposal All asbestos containing waste.	Scrap from cutting and fitting of pipe covering, and block -- discarded asbestos cement. Demolition.	Material enclosed in tightly closed bags or containers and moved in covered trucks to a sanitary land fill.
Spray application	Enclosure of spray area perimeter, stair wells, elevator shafts and hopper charging areas with canvas plastic or solid board. After completion of spray operation, the area is shoveled, swept and vacuumed clean.	

SPRAY APPLICATIONS

During the 1960's the use of asbestos in fireproofing spray application has increased greatly. The use of fireproofing spray has many advantages for the designer, the builder, and the consumer. The designer is able to design a building more pleasing to the eye, the builder saves construction time and the consumer public enjoys a safe, economic building. Advantages are accompanied by disadvantages. The application of sprayed mineral fiber containing asbestos as presently done in the United States contributes large quantities of asbestos fiber into the ambient air each year. The spray application of insulation is described in detail in a paper by Reitze, Nicholson, and Selikoff[13] now in press. Briefly, the method is as follows: A commercially prepared dry mix is emptied into a hopper and pneumatically conveyed to a nozzle. At the nozzle the material is mixed with water and the resultant material sprayed upon the surface to be fireproofed.

In another application method the material is mixed with water and the slurry is pumped to the point of application. These materials are applied to structural steel members of high rise buildings, columns, spandrels, bar joists, etc., as well as the steel decking between floors. In most cities throughout the United States readily visible quantities of asbestos containing material are added to the ambient air during this spray application. Since May of 1970 when New York City introduced stringent regulations governing the spray operation, great progress has been made in developing potentially effective control procedures.

Paragraph 2 of the orders issued by the New York City Commission of Air Resources read as follows:

> 2. The entire floor, or the part of the floor to be insulated shall be enclosed with plastic or other approved tarpaulins in a manner which shall preclude the escape of asbestos-containing material from the enclosure. All interior open areas, such as elevator shafts, stairwells, etc., shall be enclosed in a manner which shall prevent the escape of asbestos-containing material from the working area. "Stack effect" of the shafts, stairwells, etc., shall be considered in providing proper enclosures. An enclosure will be considered satisfactory only if visible insulating material cannot escape from the enclosure.[14]

Canvas or plastic is used to enclose building perimeters, stairwells and elevator shafts. Special tarps have been made on a customized basis to accommodate the different column and spandrel placement. Waste material is promptly shoveled or vacuumed into plastic bags for disposal.

Other methods for control of emissions from spray are currently being worked on. A method of pre-damping the [illegible] material, developed by Turner-Newell Company in England, is currently being studied for possible adaptation to American methods. Manufacturers are altering formulations in order to reduce asbestos fiber content.

Nevertheless, despite these advances, it must be considered that methods of controlling asbestos fiber emissions from construction sites are still in the developmental stage.

<u>COST</u>

Cost of asbestos fiber control varies greatly. The type of control units needed in milling and manufacturing, i.e. - bag house, carries a moderate to high cost - particularly in initial investment. However, one should not lose sight of the fact that many collection units also serve to collect product and material that can be returned to the manufacturing process. Cost of control in the construction industry is far more difficult to determine. Many of the control procedures are very simple in themselves but since they involve work practices, the supervision must be close and constant. The cost of control in spray application must be viewed in proper perspective. The comparison of costs between a spray job with proper control measures and one without such measures does not reveal the entire picture. When evaluating spray control costs, the cost of a steel and reinforced concrete building which uses no spray should properly serve as a base line.

EMISSIONS FROM NATURAL SOURCES

If we were able to obtain 100% control and prevent asbestos fiber from entering the ambient air from mining, milling, manufacturing, or construction processes it may be that we would still have fiber from naturally occurring sources entering the atmosphere. When we test for man-made sources of fiber pollution, we must consider the background levels which nature might contribute to the ambient air.

In the United States asbestos fiber occurs in almost all of the 50 states. When Mr. Henry W. Johns, founder of the Johns-Manville Corporation, needed material for his roofing business in 1879 - the asbestos fiber he used came from workings in one of New York City's boroughs. Asbestos fiber outcropping can still be found in the confines of New York City. Those areas of the world where serpentine rock abounds, such as the Appalachian Ridge, are particularly rich in asbestos. All serpentine rock contains minute quantities of asbestos fiber.

Asbestos from these naturally occurring sources may enter the ambient air in several ways. Exposed rock surfaces are subject to wind and water erosion. Rock slides may contribute asbestos fiber to the ambient air. Finally, when serpentine rock is crushed and used for road construction, it may contribute to the fiber found in ambient air.

SUMMARY

Asbestos is not only extremely useful but in some areas highly essential to our life. But, like most other agents used today, asbestos can, if improperly handled, produce adverse effects upon our health. With certain exceptions the technology to control asbestos fiber emissions into ambient air is available; it only need be applied. The most notable exceptions where practical solutions still need considerable development are - (1) open pit mining, (2) certain segments of the construction industry.

ABSTRACT

The body of information presented in this paper is directed to engineers engaged in industrial control or governmental enforcement activities. The chief sources of fiber emissions are listed and evaluated. These sources, i.e. mining, milling, manufacturing and certain segments of the construction industry are discussed and currently accepted methods of control are given. While present technology is adequate - if properly applied - for milling and manufacturing operations, much more work must be done to develop adequate pollution controls for open pit mining and certain types of construction work. One of the newer sources of emission in the construction industry - spray application of asbestos containing material - is discussed in detail. The problem of asbestos released to ambient air from naturally occurring sources is mentioned.

The conclusions reached indicate that with time, effort, money and a lot of ingenuity, the amount of asbestos fiber released to ambient air can be substantially reduced.

BIBLIOGRAPHY

1. Murray, H.M., 1907 In Report of the Departmental Committee on Compensation for Industrial Disease. Minutes of Evidence, Appendices and Index: c.d. 3495, c.d. 3496 Wyman and Sons, London, England.

2. Merewether, E.R.A. and Price, C.W., 1930 Report on Effects of Asbestos Dust on the Lungs and Dust Suppression in the Asbestos Industry, Her Majestys Stationary Office

3. Harries, P.G., 1968 Asbestos Hazard in Naval Dockyards. Ann. Occup. Hyg. 11:135 145

4. Selikoff, I.J., Churg, J. and Hammond, E.C., 1964 Asbestos Exposure and Neoplasia. J.A.M.A. 188:25-26

5. Selikoff, I.J., Churg, J. and Hammond, E.C., 1965 Relation Between Asbestos Exposure and Mesothelioma. New Eng. J. Med. 272:560-565

6. Selikoff, I.J., Churg, J. and Hammond, E.C., 1965 The Occurrence of Asbestosis Among Asbestos Workers in the United States. Ann. of the N.Y. Acad. of Sciences 132:129-155

7. Hammond, E.C., Selikoff, I.J., Churg, J, 1965 Neoplasia Among Insulation Workers in the U.S. With Special Reference to India Abdominal Neoplasia. Ann. of the N.Y. Acad. of Sciences 132: 516-525

8. Kiviluoto, Raimo, 1965 Pleural Plaques and Asbestos: Further Observations on Endemic and other Non-Occupational Asbestosis. Ann. of the N.Y. Acad. of Sciences 132:235-239

9. Laamanen, Aruo, L. Noro, V. Raunio, 1965 Asbestos Air Pollution. Ann. of the N.Y. Acad. Sciences 132:240-245

10. Thomson, J.G., 1965 Asbestos and the Urban Dweller. Ann. of the N.Y. Acad. of Sciences 132:196-214

11. Wagner, J.C., 1965 Epidemiology of Diffuse Mesothelial Tumors: Evidence of Air Association From Studies in South Africa and in the United Kingdom. Ann. of the N.Y. Acad. of Sciences 132: 575-578

12. Newhouse, Muriel L. and Thomson, H, 1965 Epidemiology of Mesothelial Tumors in the London Area. Ann. of the N.Y. Acad. Sciences 132:579-588

13. Reitze, W.B., Nicholson, W.J., Selikoff, I.J., 1970 Application of Sprayed Inorganic Fiber Containing Asbestos: Occupational Health Hazards. In press

14. New York City Department of Air Resources Regulations, 1970, In The Matter of the Spraying of Asbestos- Containing Materials - Commissioner's Order

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Asbestos related diseases have been known in occupational groups for some years. The first case of asbestosis (extensive pulmonary fibrosis) was reported by Montague Murray [1] in 1906. Early studies dealt primarily with factory populations. More recently, investigators have studied workers who handled asbestos products outside the factory environment.

Asbestos related disease among the shipyard workers was well documented by Harries [2] and others. Selikoff [3-6] and coworkers have engaged in some very comprehensive studies of the construction trades. His work not only confirmed asbestosis findings but pointed to an increase in incidence of bronchogenic cancer and pleural and peritoneal mesothelioma.

These reports dealt with occupational exposure – either factory or ~~[illegible]~~ certain segments of the construction industry. During the 1950's investigators began studies of ~~[illegible]~~ selected non-occupational population groups and their relationship to asbestos related neoplasms. Kiviluoto [7] and Lanmanen [8] of Finland, Thomson [9] and Wagner [10] in South Africa, Newhouse and Thomson [11] in London as well as investigators in the United States have published reports suggesting ~~[illegible]~~ a higher than normal rate of certain diseases ~~[illegible]~~ among ~~[illegible]~~ people living in the vicinity of some asbestos factories and mines.

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While much speculative material has been published on the potential health hazard of asbestos in the ambient air to the general public — those people not occupationally exposed to asbestos, those living in the vicinity of asbestos [illegible] and mines — ~~[illegible]~~ the limited factual data collected leaves us ~~[illegible]~~ with many unanswered questions. What is the present level of asbestos fiber in ambient air? What are the large sources of fiber emissions into the air? What are safe limits of asbestos fiber in ambient air? When we speak of asbestos fiber as a causal agent in neoplasms of what size fiber are we speaking? Are there any cocarcinogens involved?

Studies are currently underway seeking answers to these questions. Some much needed information will not be available for several years. In the meantime it ~~[illegible]~~ would be advisable as a precautionary measure to take steps to reduce the amount of asbestos fiber that is permitted to enter the ambient air.

There are five major sources from which asbestos fiber enters the air - (1) mining (2) milling (3) manufacturing (4) certain segments of the construction ~~trades~~ industry and (5) naturally occurring sources. The first four are created by modern man's technology and the last by normally occurring changes in our environment.

First let us consider mining, and milling. Since most of the asbestos mined in North America is taken from open pit mines, the problem of controlling fiber emissions into the ambient air is difficult to solve. Listed in the charts below are the chief operations in both the mines and mills and the chief methods of control currently in use in North America.

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Material Handling Handling	Filtered air cab (protects worker only) Covered load - canvas
Roadways	Road stabalization program - oil chemical water
Waste disposal	Tailings are covered with earth - reforestation

Control methods in certain mining operations leave much to be desired. Methods for controlling emissions from blasting ~~is~~ ARE virtually non-existant. Dust controls in material handling still need considerable development.

MILLING

Crushing	Bag Filter* - a cyclone may be used as a primary collector
Ore drying	Bag Filter - a cyclone may be used as a primary collector
Milling	Bag Filter
Classification Air Separation	Bag Filter
Packaging	Bag Filter
Solid waste disposal	Tailings are covered with earth - reforestation
	* Filters usually enclosed in a negative pressure bag house.

The technology to effectively control asbestos milling emissions is on the shelf. Bag filters with an efficiency in excess of 99% are readily available. Recent discussions regarding the relationship of bag house efficiency and fiber size have pointed up the need for more data from the medical community regarding the biologic activity of the submicron asbestos fibers.

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The chart below lists some major operations which are common to production lines using asbestos.

MANUFACTURING

Asbestos cement product - floor tile - friction material - plastics, etc.

Dry and/or Wet mix	Bag opening Bag dumping Bag disposal	Enclosure or hood to bag house Wet scrubbers are also used for dry mix
Pressing - Moulding - Forming -	Wet stock Wet furnish Wet furnish	No dust Slurry - no dust Slurry - no dust
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With few exceptions the negative pressure bag house is perhaps the unit of choice for asbestos fiber control in a manufacturing process. A high efficiency (99%+) is necessary for adequate control.

MANUFACTURING

Asbestos Textile

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Weaving Spinning Twisting	Certain operations may be performed while the fiber is moist thereby reducing dust.
Material handling Bag opening Bag emptying Bag disposal Bins Bobbins Spools	Enclosure or hood to bag house

In textile manufacturing emission control is slightly different in that much of the dust can be suppressed by use of water in the weaving, twisting, and spinning, phases. Asbestos textile processing is still the most troublesome of the manufacturing operations involving asbestos.

CONSTRUCTION USES

The bulk of the asbestos used in the world is consumed by tho construction industry. Steam pipes and boilers are insulated with a calcium silicate material containing 5-15% asbestos fiber. An asbestos fiber containing cement is used to plaster boilers, breechings and reactor vessels in chemical plants and oil refineries. Asbestos containing board is used aboard ship for fireproof bulkheads. In spite of the fact that the construction trades use many dozens of asbestos containing products, the use of most of these products (those with asbestos "locked-in" by plastic or cement) contributes very little to ambient air pollution.

Solikoff[6] has pointed out that use of asbestos containing material creates a severe health hazard to the insulation worker. This occupational hazard is largely due to the fact that the material becomes airborne, in an enclosed area. On the other hand, this very fact works agai[illegible] asbestos fiber entering the ambient air. Often, when an attempt is made to reduce asbestos health hazards in the work place, such as air removal from a ship's compartment or an insulation fabrication shop, the results are disadvantageous to the ambient air. Any time asbestos containing material is removed from a work place, extreme care should be taken to prevent its escape into ambient air. Bag house collectors are available which collect dust from fabrication shop machinery and deposit it in a disposable plastic bag. Perhaps one of the greatest sources of asbestos fiber emissions to ambient air from certain construction applications arises from poor housekeeping on construction sites. Saw dust and scrap from the cutting and fitting of calcium silicate block and pipe covering are scattered about building sites. The material is then ground underfoot or truck tires and carried away. A small portion eventually becomes airborne. Control methods for this type of emission demands care, common sense and good housekeeping practices rather than sophisticated dust collecting equipment.

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The above operations are customarily performed in confined areas. The air pollution usually arises from efforts to reduce dust in the work place.		
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SPRAY APPLICATIONS

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<u>COST</u>

Cost of asbestos fiber control varies greatly. The type of control units needed in milling and manufacturing, i.e. - bag house, carries a moderate to high cost - particularly in initial investment. However, one should not lose sight of the fact that many collection units also serve to collect product and material that can be returned to the manufacturing process. Cost of control in the construction industry is far more difficult to determine. Many of the control procedures are very simple in themselves but since they involve work practices, the supervision must be close and constant. The cost of control in spray application must be viewed in proper perspective. The comparison of costs between a spray job with proper control measures and one without such measures does not reveal the entire picture. When evaluating spray control costs, the cost of a reinforced concrete building which ~~needs~~ uses no spray should properly serve as a base line.

EMISSIONS FROM NATURAL SOURCES

If we were able to obtain 100% control and prevent asbestos fiber from entering the ambient air from mining, milling, manufacturing, or construction processes it may be that we would still have fiber from naturally occurring sources entering the atmosphere. When we test for man-made sources of fiber pollution, we must consider the background levels which nature might contribute to the ambient air.

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BIBLIOGRAPHY

1. Murray, H.M., 1907 In Report of the Departmental Committee on Compensation for Industrial Disease. Minutes of Evidence, Appendices and Index: c.d. 3495, c.d. 3496 Wyman and Sons, London, England

2. Harries, P.G., 1968 Asbestos Hazards in Naval Dockyards. Ann. Occup. Hyg. 11:135-145

3. Selikoff, I.J., Churg, J. and Hammond, E.C., 1964 Asbestos Exposure and Neoplasia. J.A.M.A. 188:22-26

4. Selikoff, I.J., Churg, J. and Hammond, E.C., 1965 Relation Between Asbestos Exposure and Mesothelioma. New Eng. J. Med. 272:560-565

5. Selikoff, I.J., Churg, J. and Hammond, E.C., 1965 The Occurrence of Asbestosis Among Asbestos Workers in the United States. Ann. of the N.Y. Acad. of Sciences 132:139-155

6. Hammond, E.C., Selikoff, I.J., Churg, J., 1965 Neoplasia Among Insulation Workers in the U.S. With Special Reference to India Abdominal Neoplasia. Ann. of the N.Y. Acad. of Sciences 132: 516-525

7. Kiviluoto, Raimo, 1965 Pleural Plaques and Asbestos. Further Observations on Endemic and other Non-Occupational Asbestosis. Ann. of the N.Y. Acad. of Sciences 132:235-239

8. Laamanon, Aruo, L. Noro, V. Raunio, 1965 Asbestos Air Pollution. Ann. of the N.Y. Acad. Sciences 132:240-245

9. Thomson, J.G., 1965 Asbestos and the Urban Dweller. Ann. of the N.Y. Acad. of Sciences 132:196-214

10. Wagner, J.C., 1965 Epidemiology of Diffuse Mesothelial Tumors: Evidence of Air Association From Studies in South Africa and in the United Kingdom. Ann. of the N.Y. Acad. of Sciences 132: 575-578

11. Newhouse, Muriel L. and Thomson, H., 1965 Epidemiology of Mesothelial Tumors in the London Area. Ann. of the N.Y. Acad. Sciences 132:579-588

12. Reitze, W.B., Nicholson, W.J., Selikoff, I.J., 1970 Application of Sprayed Inorganic Fiber Containing Asbestos. Occupational Health Hazards. In press

13. New York City Department of Air Resources Regulations, 1970, In The Matter of the Spraying of Asbestos-Containing Material - Commissioner's Order