FILE NAME: Phenolic Resins (PHR)

DATE: 1977

DOC#: PHR002

DOCUMENT DESCRIPTION: Unpublished Report from Conference - Monitored Asbestos Concentrations in Connecticut

MONITORED ASBESTOS CONCENTRATIONS IN CONNECTICUT

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(paper #77-48.5)

To be presented at the 70th annual meeting
of the Air Pollution Control Association,
to be held in Toronto, Ontario,
June 20-24, 1977

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Abstract

An ambient air asbestos survey was conducted during late 1975 and early 1976 to define the magnitude of the health hazard posed by airborne asbestos fibers in Connecticut prior to the promulgation of the State's propose asbestos air quality standard (i.e., 30 ηg/m³ or 30,000 total asbestos fibers/m³, 30-day average). A newly developed low volume particulate sampler, which operates continuously for 30-days at an air sampling flow rate of 4 cfm, equipped with special membrane filters was used to collect ambient TSP samples for subsequent chrysotile asbestos electron microscopic determination by the Batelle-Columbus Laboratories.

Approximately 30 monitoring sites were selected; locations included "typical" urban sites removed from known sources of asbestos emissions, rural-background sites and stations contiguous to 4 industrial users of asbestos (i.e., manufacturers of friction products, insulated wire and cable, ammunition and molding compounds) and 3 toll plazas situated at various points along Interstate-95. Ambient chrysotile asbestos levels removed from asbestos emission sources in both urban and rural locations were below 10 ηg/m³. However, asbestos concentrations above 30 ηg/m³ were measured near each of the industrial users of asbestos. Furthermore, asbestos levels adjacent to the toll plazas were also elevated (in the 10 ηg/m³ to 25 ηg/m³ range), implicating asbestos emissions from vehicle braking lining decomposition as a significant source of airborne asbestos fibers.

Introduction

Asbestos, the general term used to describe a class of fibrous silicate minerals, is widely used in industry and construction. The principal variety of asbestos used in industry is the serpentine form known as chrysotile (greater than 95%) with the amphibole forms of asbestos being of lesser significance. Occupational asbestos fiber exposure has been known for some time to cause severe respiratory problems, including lung cancer and a relatively rare form of cancer of the lining of the lung and stomach, known as "mesothelioma". Recently, the previously rare mesothelial malignancy has been linked to non-occupational asbestos fiber exposure.[1-9]

In 1973 the Federal EPA, recognizing the need to control the emissions of asbestos fibers into the ambient air, promulgated National Emission Standards For Hazardous Air Pollutants (asbestos, beryllium, and mercury).[10] After an extensive review, the Connecticut DEP found EPA's asbestos regulation to be inadequate for the purposes of protecting public health in Connecticut and, consequently, developed its own asbestos regulation.[11,12] While EPA's asbestos regulation was written in rather general terms (i.e., "no visible emissions or application of best available control technology"), Connecticut proposed a numerical ambient air quality standard of 30 ng/m^3 or 30,000 total asbestos fibers per cubic meter of air sampled, 30-day average, and a compatible mass emission standard of 24 g/day. In the judgement of the Connecticut DEP a "no visible emission" asbestos air quality standard does not provide the State's residents with an adequate degree of protection from this carcinogenic substance.

In order to define the magnitude of the hazard posed by airborne asbestos fibers in Connecticut prior to the promulgation of the State's proposed standard the DEP conducted an ambient air asbestos survey along with a study of asbestos-induced mesothelioma incidence in Connecticut. The results of the health study indicated that Connecticut's mesothelioma incidence rate has exhibited a 10-fold increase since 1940. This rapid rise in the State's mesothelioma incidence rate closely parallels Connecticut's rate of increase in cumulative asbestos consumption. Approximately 90% of these mesothelioma cases did not have a trade where exposure to asbestos was a common feature. The results of this study are described elsewhere.[13] The ambient air asbestos survey was conducted during 1975 at approximately 30 monitoring sites; locations included rural and semi-rural locales, urban areas, and stations situated contiguous to known sources of asbestos emissions (e.g., industrial users of asbestos and toll plazas). A newly developed low volume particulate sampler was used to collect samples for subsequent chrysotile asbestos determination by the Batelle-Columbus Laboratories. The following discussion presents the results of Connecticut's ambient air asbestos survey.

Sources of Airborne Asbestos Fibers in Connecticut

The manufacture of products which contain asbestos, such as asbestos cement, floor tile, paper, friction materials and textiles, are the major sources of ambient airborne asbestos fibers in Connecticut, accounting for approximately 10 tons of asbestos emissions each year.[12,13] Another potentially significant source of airborne asbestos fibers is the erosion of vehicle brake linings and clutch facings and subsequent release of asbestos. Asbestos is used in vehicle brake linings to provide strength, heat resistance, and selective decomposition

under stress. Chrysotile asbestos constitutes approximately 50% (by weight) of most vehicle brake linings manufactured in the United States.[14] During braking the application of energy is so intense and the heat created so great that most of the asbestos fibers are converted to other non-fibrous substances, however, a significant percentage remain in the asbestos form. Consequently, it is possible that ambient asbestos levels contiguous to areas of extensive vehicle braking, such as toll plazas, may be significantly higher than background locations. In Connecticut, the erosion of vehicle brake linings and clutch facings is estimated to contribute an additional 2 tons of asbestos fibers into the ambient air annually.[12] Perhaps the largest potential future source of asbestos emissions in Connecticut will be the demolition of structures containing asbestos floor and ceiling tiles and which have been insulated and/or fireproofed with asbestos materials.[13]

The health risk posed to the general population by asbestos fibers is not limited to either the indoor occupational environment or the outdoor ambient air. Many do-it-yourself home projects create asbestos dust due to the mixing of dry, loose asbestos with water and subsequent application of such mixtures for the purposes of insulating and/or fireproofing boilers, pipes, etc..., the cutting and sawing of asbestos-containing wallboard, ceiling and floor tile and the sanding of spackling compounds containing asbestos. Perhaps the more serious public health hazard posed at this time by excessive asbestos fiber exposure has been created by the release of asbestos fibers from asbestos-containing surface coatings, which were applied indoors to walls, ceilings, exposed structural steel, air ducts, plenums, return air spaces for insulating (thermal and acoustic) decorating and fireproofing purposes indoors. As a result of such applications appreciable amounts of asbestos fibers may be released into the air indoors during the application, again as the surface coating deteriorates, and finally, when the building is demolished. The asbestos fibers resulting from the spraying operation itself, as well as those released from the coating over a period of time due to its friable nature, are of primary public health concern. At least one state (i.e., New Jersey) has already drafted regulations for the purposes of controlling and/or prohibiting the future use of spray-on asbestos surface coatings. NESHAPS prohibits the use of such asbestos-containing spray-on insulation and fireproofing materials outdoors;[10] a recent ammendment to NESHAPS proposes to prohibit the future use of any type of spray-on asbestos coatings indoors.[15]

Sampling Methodology

Connecticut's proposed asbestos ambient air quality standard is based on a 30-day average sampling period instead of the usual 24-hour duration because a one-month averaging time is more manageable from a monitoring standpoint, is also not sensitive to short-term pertubations in asbestos emissions, yet still provides the public with a high degree of protection from the adverse health effects caused by excessive asbestos fiber exposure. In order to determine compliance with such a standard a new type of low volume ambient particulate sampler, which operates continuously for 30 days, was developed.[16,17]

This low volume particulate sampler (lo-vol) was designed around the constraints that it must use an air sampling flow rate low enough to prevent filter overloading and subsequent biasing of the sample toward the beginning of the 30-day sampling interval. The lo-vol produced measurement is essentially an arithmetic average for the entire 30-day sampling period.

The lo-vol is essentially a combination of parts taken from a conventional hi-vol sampler and a stack sampling train (see Figure 1). The lo-vol consists of a modified hi-vol shelter, filter holder, transition piece, a temperature compensating dry gas meter and a vacuum pump. The hi-vol transition piece is used as the lo-vol's filter holder. The transition piece has been fitted with a specially designed stainless steel adapter plate and is connected to the dry gas meter with thick-walled (i.e., 0.5 inch inside diameter, 0.75 inch outside diameter) tygon tubing. The dry gas meter is an American Meter #AL250, which is temperature compensating at 60°F and rated at 250 cubic feet per hour (CFH). The meter has been fitted with standard gas pipe connections sized to fit the tygon tubing. This meter provides an air sampling flow rate measurement accuracy of ±0.01 cubic feet per minute. The power for the lo-vol is supplied by an oiless Gast Rotary Vane Pump Model #0522, which delivers 200 CFH at a pressure of 5 inches of mercury. The lo-vol operates at an air sampling flow rate of 4 cfm or 1/10 of that used by a conventional hi-vol sampler. Therefore, a lo-vol filter collects approximately 2 to 3 times as much sample, by weight, as compared to that amount collected by a standard 24-hour hi-vol. Thus the lo-vol should provide a more accurate chemical characterization of the TSP, especially for those substances which are usually present in very low concentrations, such as asbestos.

As a quality control check on the performance of the lo-vol the Connecticut Department of Environmental Protection co-located a lo-vol and a hi-vol on the roof of the State Office Building, located in Hartford, Connecticut. Continuous TSP data were collected for a 1-year period. Monthly mean TSP concentrations obtained using the lo-vol were, on the average, 7% greater than the arithmetic mean of 30 consecutive non-overlapping daily hi-vol measurements for the 12 30-day intervals. A detailed description of this test program is reported elsewhere.[15,17]

Membrane collection filters (8" x 10", Gelman* Metricel GN-6, 0.45μ pore size, non-nylon reinforced) were used since the glass fibers in conventional fiber glass filters interfere with the analytical technique used to ascertain the asbestos content of air samples. The chrysotile asbestos analysis was performed by the Batelle-Columbus Laboratories using electron microscopy;[18] the accuracy of the method used to determine the asbestos content of the air samples was estimated to be ±50%, based on the analysis of activated chrysotile asbestos samples.[19] Analytical results are expressed in terms of mass of chrysotile asbestos per cubic meter of air sampled.

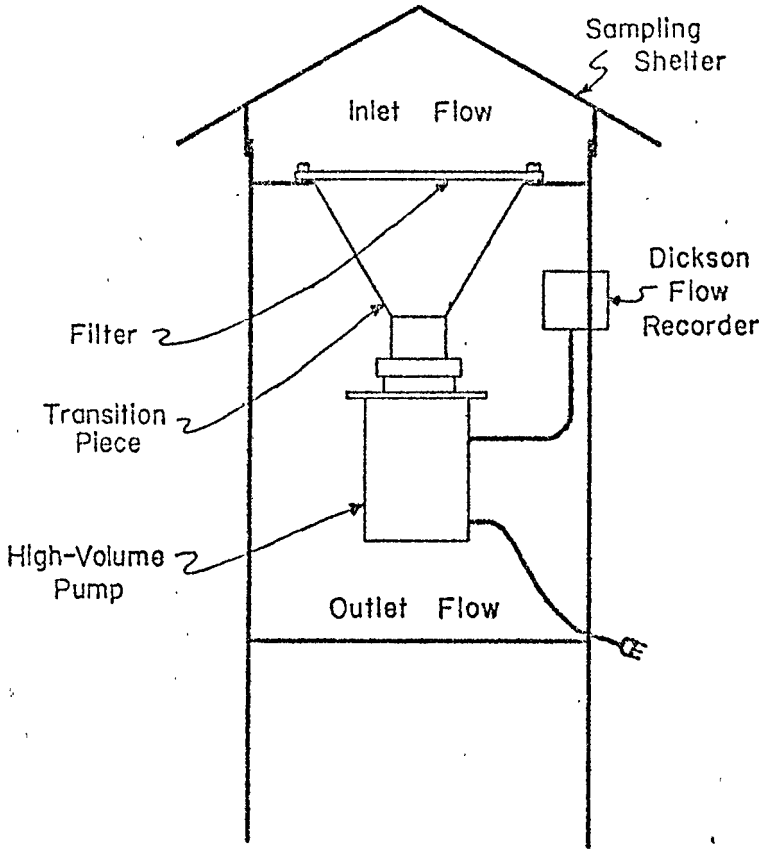
Sampling Locations

Approximately 30 monitoring sites were selected (see Figure 2); locations included "typical" urban and rural background areas and stations contiguous to 4 manufacturing sources of asbestos emissions (i.e., a manufacturer of friction products, a manufacturer of insulating wire and cable, a manufacturer of ammunition and a manufacturer of molding compounds) and 3 toll plazas situated at various points along the Connecticut Turnpike (I-95).

Source #1 uses approximately 600 tons of asbestos per month in the manufacturer of asbestos containing friction and gaskets materials. This source has over 1,000 point ventilation streams at mixing (i.e., raw materials includ-

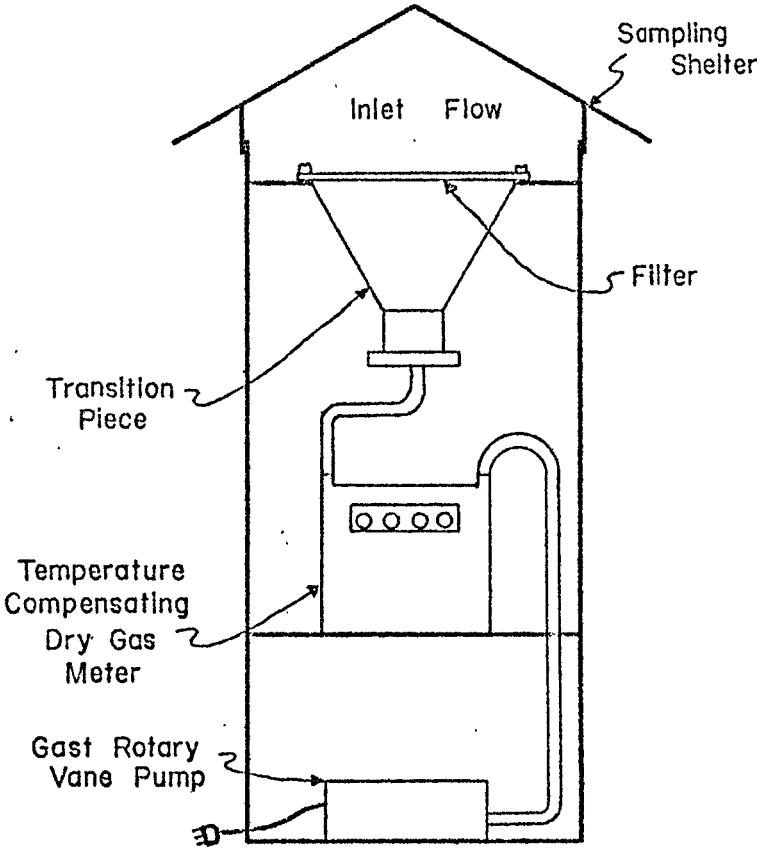
*Mention of commercial products or company name does not constitute endorsement by the Connecticut Department of Environmental Protection.

Figure 1. High Volume (Hi-Vol) and
Low Volume (Lo-Vol) Ambient TSP Samplers



High-Volume Sampler

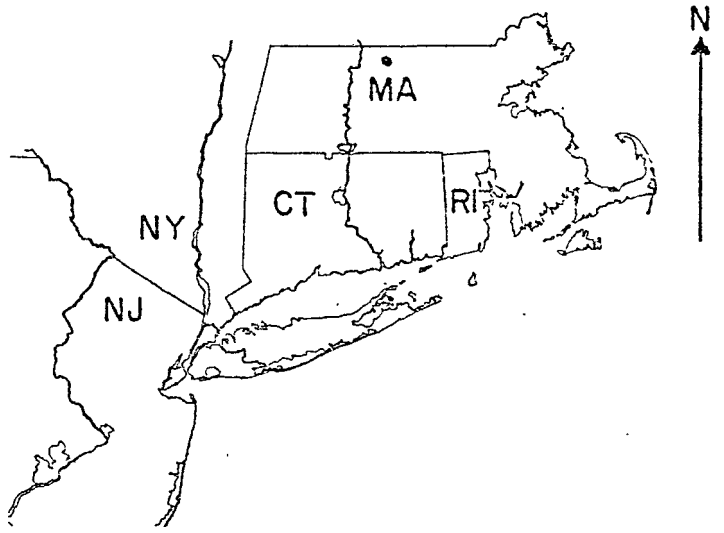
Figure I. High volume (hi-vol) and samplers.



Low-Volume Sampler

low volume (lo-vol) ambient TSP

Figure 2. Map Depicting Location of Asbestos Monitoring Sites



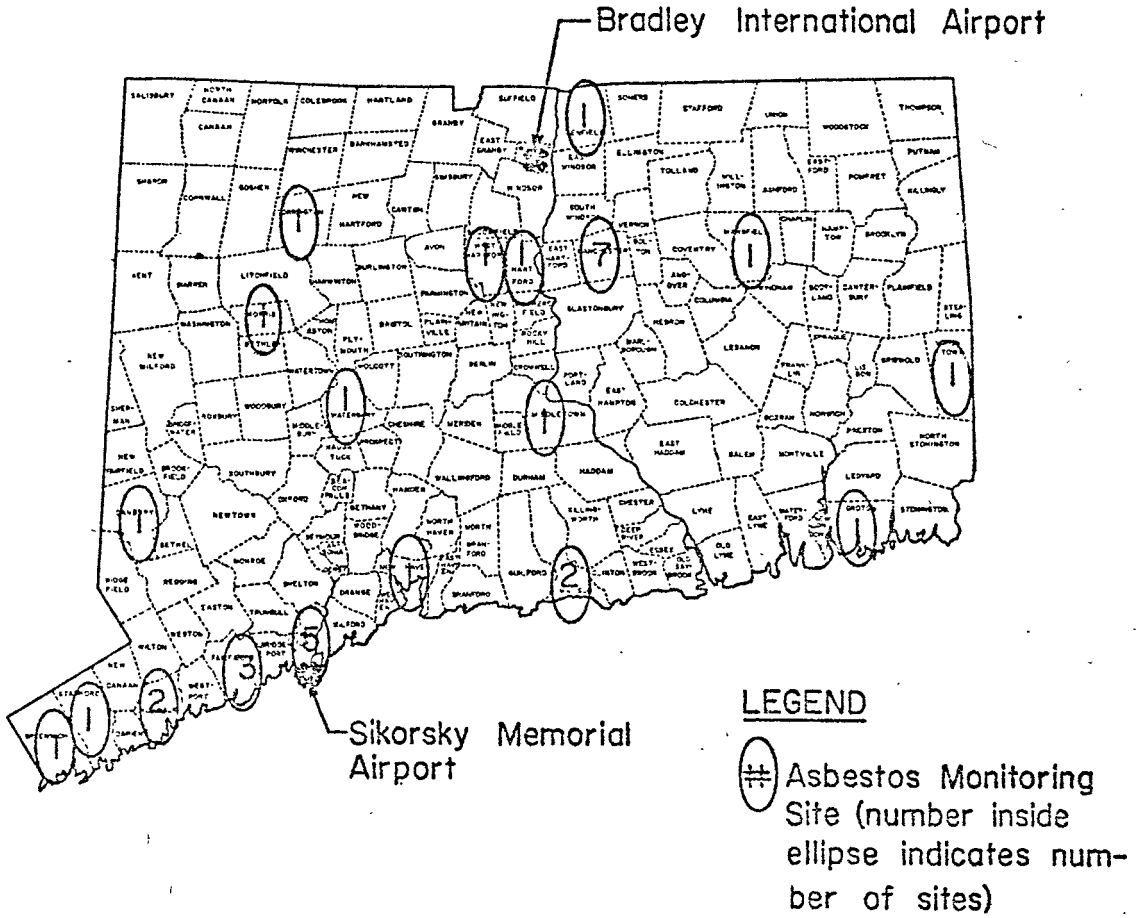


Figure 2. Map depicting location of asbestos monitoring sites.

ing asbestos and other inert materials are compounded on various types of mixing devices), forming (i.e., compounds are formed into pads and various friction and gasket products) grinding and machining operations. These streams are combined into 20 final streams, each exhausting to the atmosphere through an air mover and a control device (i.e., 10 baghouses and 10 wet cyclone-venturi scrubber combinations; estimated asbestos control efficiency 98-99%+).

Source #2 uses approximately 3-6 tons of asbestos per month in the manufacturer of insulated wire and cable. Asbestos is applied to wire and cable using carding, taping and braiding machines. The carding machines vent to baghouses, each collecting exhaust from 2 machines. There are 3 sizes of braiders at this plant, sized according to the number of spindles in the braids. The small braider exhausts to a baghouse, then vents to the outside. The medium and large braiders are exhausted to a separate piece of control equipment and are vented inside the plant. The taping machine is controlled by a cyclone-baghouse combination and also vents inside. All control equipment used here are estimated to be 99%+ efficient in removing asbestos from waste streams.

Source #3, which is located about 1/2 mile from source #2, uses approximately 40 tons of asbestos per month in the manufacturer of ammunition. Here, chrysotile asbestos is blended with wood flour and parrafin wax. This blended material is then mixed in a steam heated ribbon blender and stored in a silo for feeding into a Colton Tablet machine where the "wads" are formed into their final shape. The blending operation is vented to a wet cyclone which has an estimated asbestos control efficiency of approximately 95%.

Source #4 uses approximately 150 tons of asbestos per month in the manufacturer of molding compounds. One process involves the mixing of dry powdered phenolic resins with glass, asbestos and other additives. This mixture is then transferred to a shaping line where the dry resin mixture with added plasticizer is milled and compounded to a desired thickness. Then the sheet is pre-ground and carried by a vacuum line back to the area where it was originally mixed. There it is processed by sizing screens to a desired mesh size. Then a large batch is blended to maintain consistency and packaged for sale. Another process combines formaldehyde-phenol liquid resins with dry resins and various grades of asbestos. This mixture is kneaded, extruded, dried and sized. Large amounts are blended and packaged. The last process involves blending pulp, dry resins, asbestos and fillers and then forming a sheet on a cylinder paper machine. Asbestos is added to the beater just before the pulp is dumped to the stock chest. The sheet can be of varying thickness up to 3/8". It is oven dried after forming, then sized to sheets 4' x 5' and sold. In the first process the mixing tank, sizing screens and blender are exhausted to a baghouse. The sizine line has exhaust from the fluxing mill and the pre-grinder which is also collected in a baghouse. The 3 extrusion lines have sizers and driers exhausting to 3 separate baghouses. The 2 beaters where asbestos is added are hooded and also exhaust to a baghouse, which collects dust from the 3 loading chutes and kneaders used in the extrusion lines. All the baghouses are rated at a 99%+ asbestos removal efficiency.

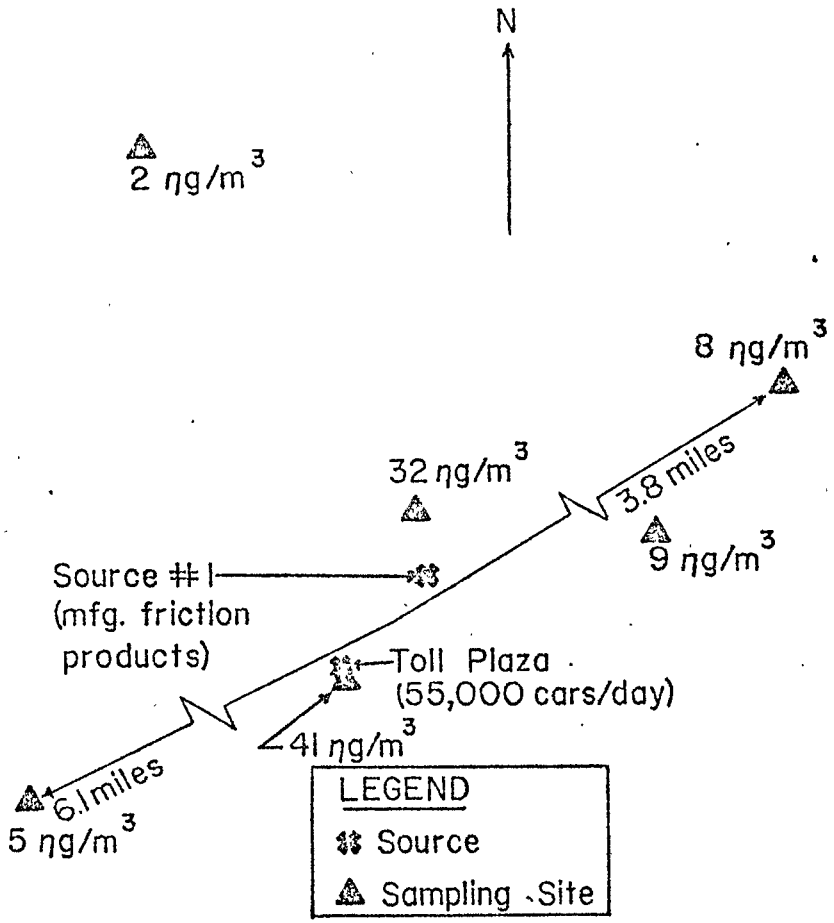
Results and Discussion

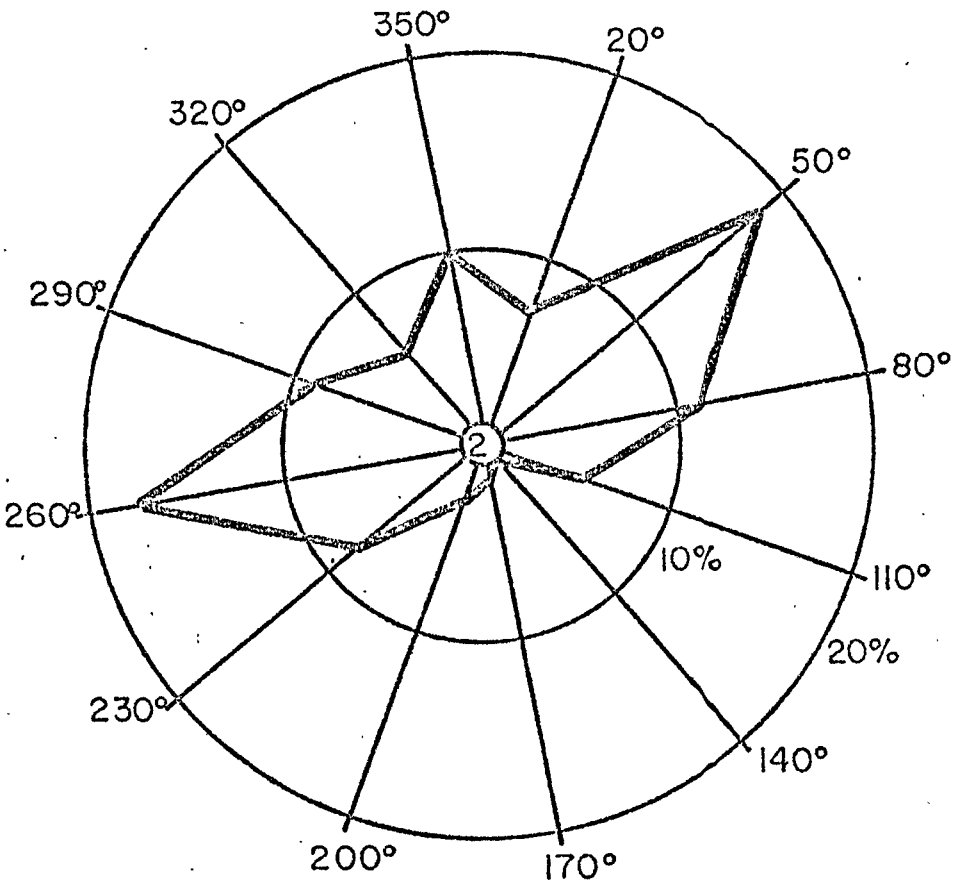
Ambient chrysotile asbestos concentrations removed from significant point sources of asbestos emissions in both rural and urban locations were below 10 ng/m^3. For the 5 rural sites asbestos levels ranged from <1 ng/m^3 to 4 ng/m^3. For the 17 urban sites removed from known sources, asbestos concentrations varied from <1 ng/m^3 (almost half of the urban sites) to 9 ng/m^3. However, asbestos levels at the monitoring sites located contiguous to certain industrial users of asbestos in Connecticut were elevated with at least one site near each source exceeding the State's proposed 30 ng/m^3 asbestos air quality standard (i.e., 32 ng/m^3 at a Public Works building located near the friction products manufacturer; 33 ng/m^3 at a Junior High School located adjacent to the insulated cable and wire and ammunition manufacturer combination; 33 ng/m^3 at a private home near the molding compounds manufacturer - see Figures 3-5). It is noteworthy that each of the subject point sources are in compliance with NESHAPS and other existing state and federal air quality regulations.

Ambient asbestos levels adjacent to the 3 toll plazas on I-95 were also elevated (in the 10 ng/m^3 to 25 ng/m^3 range), implicating asbestos emissions from vehicle brake lining decomposition as a significant source of airborne asbestos fibers (see Figure 6). Asbestos concentrations at the rural toll plaza (11,000 cars/day eastbound lane; 12,000 cars/day westbound lane) were 10 ng/m^3 (eastbound lane) and 14 ng/m^3 (westbound lane); there are no known industrial users of asbestos near this toll station. Asbestos levels at one of the urban toll plazas (28,000 cars/day eastbound lane; 27,500 cars/day westbound land) were 3 ng/m^3 (Administration Building, south side of highway) and 25 ng/m^3 (westbound lane). The asbestos concentration at the other urban toll plaza (27,000 cars/day eastbound lane; 28,000 cars/day westbound lane), which is also located near one of the largest industrial users of asbestos in Connecticut, was 41 ng/m^3 (Administration Building, south side of highway); this was the highest concentration measured during the subject survey. The ratio of the maximum asbestos concentration measured at the first urban toll plaza to that at the rural toll station was approximately equal to the ratio of the number of cars/day passing through each toll plaza (i.e., 1.8 versus 2.3) during the sampling interval. All of the aforementioned measured asbestos levels were 30-day average values, except the 41 ng/m^3 concentration, which was approximately a 20-day average value (due to a sampler malfunction).

An attempt was made to select monitoring locations near the industrial users of asbestos in such a manner that the maximum impact of each point source would be measured during a given sampling period. However, certain of the measured values are difficult to explain if one only considers the frequency distribution of the winds during the appropriate sampling interval (see Figures 3-6). This apparent sampling anomaly might have several explanations. For example, local meteorological conditions near each source might differ somewhat from those measured at either of the two national weather bureau stations located in Connecticut. Also, the source-oriented monitoring sites were situated 1/2 mile of each source and, thus, measured asbestos concentrations could be significantly effected by fugitive asbestos emissions. Furthermore, since monitored levels are 30-day average values it is possible that a combination of wind speed and stability conditions associated with a certain wind direction might significantly effect asbestos concentrations over a 30-day period even if they occurred relatively infrequently. In any event, the close proximity of the monitoring sites which exhibited elevated asbestos levels to a particular industrial user of asbestos clearly implicates that source as the major contribution to the measured concentration.

Figure 3. Ambient Air Asbestos Survey,
10/17/75-11/14/75: Asbestos Levels Near
A Manufacturer of Friction Products, 30-Day Average





Frequency Distribution Of Wind Direction At Sikorsky Memorial Airport

Figure 3. Ambient air asbestos survey, 10/17/75–11/14/75: asbestos levels near a manufacturer of friction products, 30-day average.

Figure 4. Ambient Air Asbestos Survey, 10/17/75-11/14/75: Asbestos Levels Near A Manufacturer of Ammunition and a Manufacturer of Insulated Wire and Cable, 30-Day Average

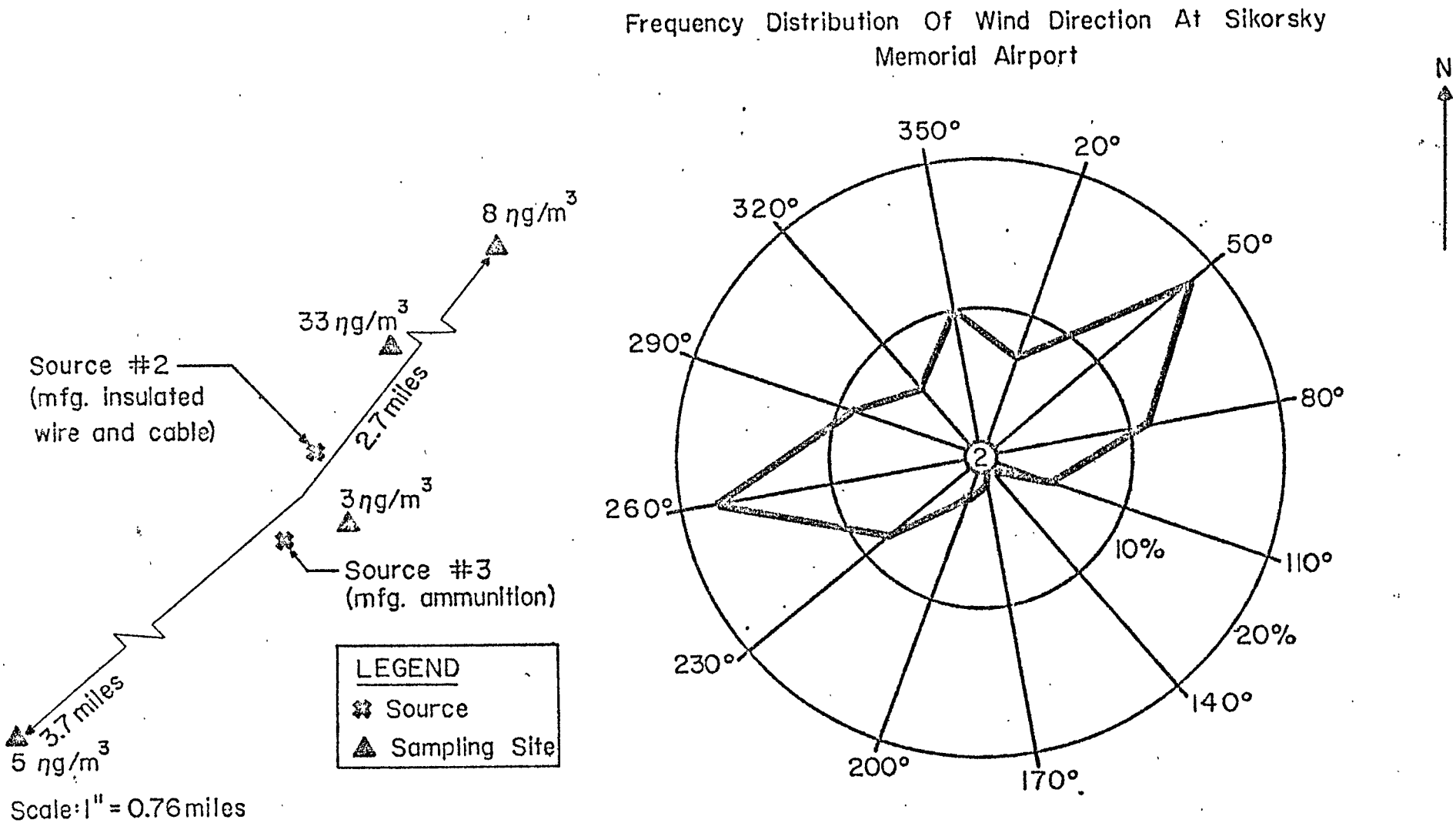


Figure 4. Ambient air asbestos survey, 10/17/75–11/14/75: asbestos levels near a manufacturer of ammunition and a manufacturer of insulated wire and cable, 30–day average.

Figure 5. Ambient Air Asbestos Survey, 1/26/76-2/27/76: Asbestos Levels Near A Manufacturer of Molding Compounds, 30-Day Average

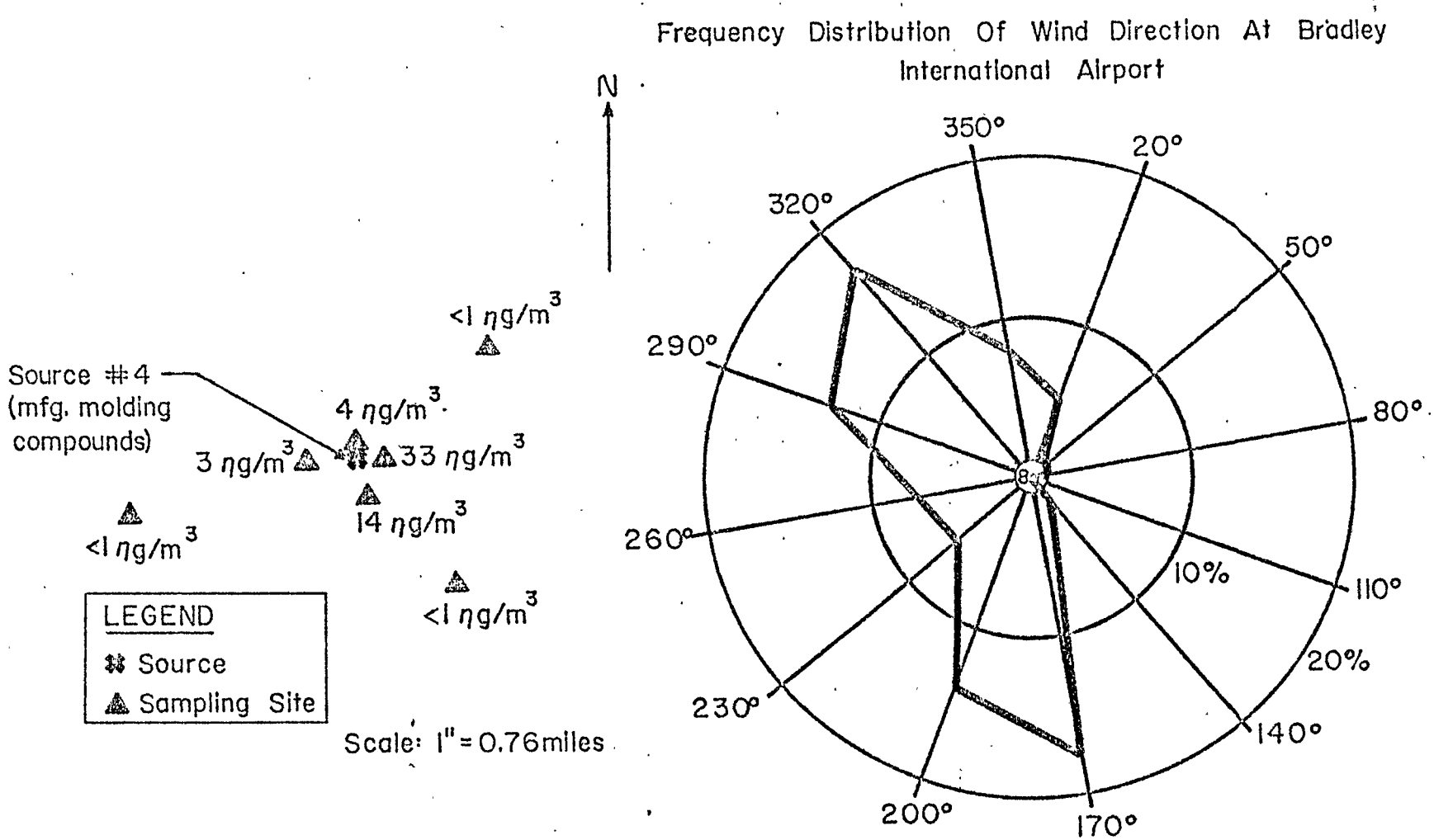
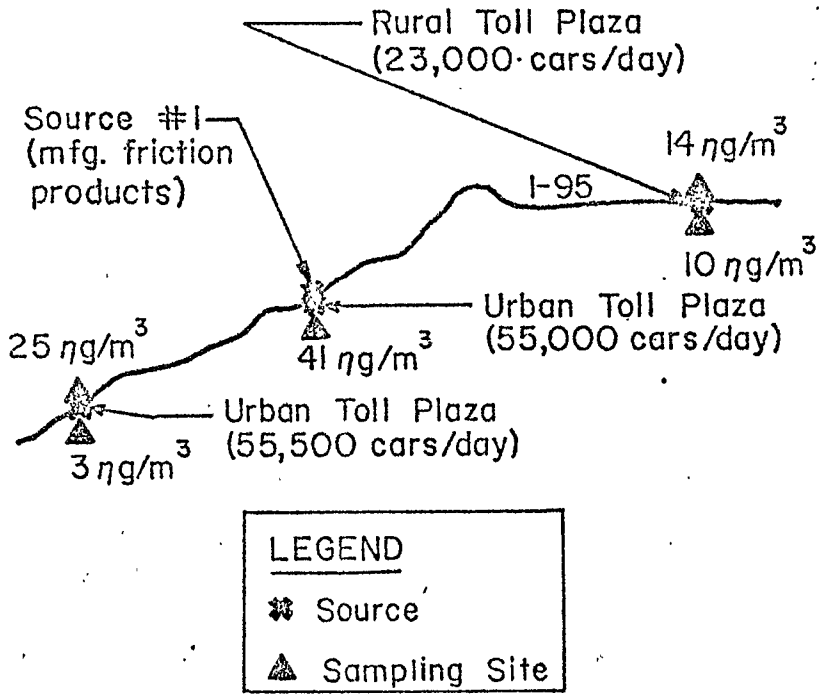
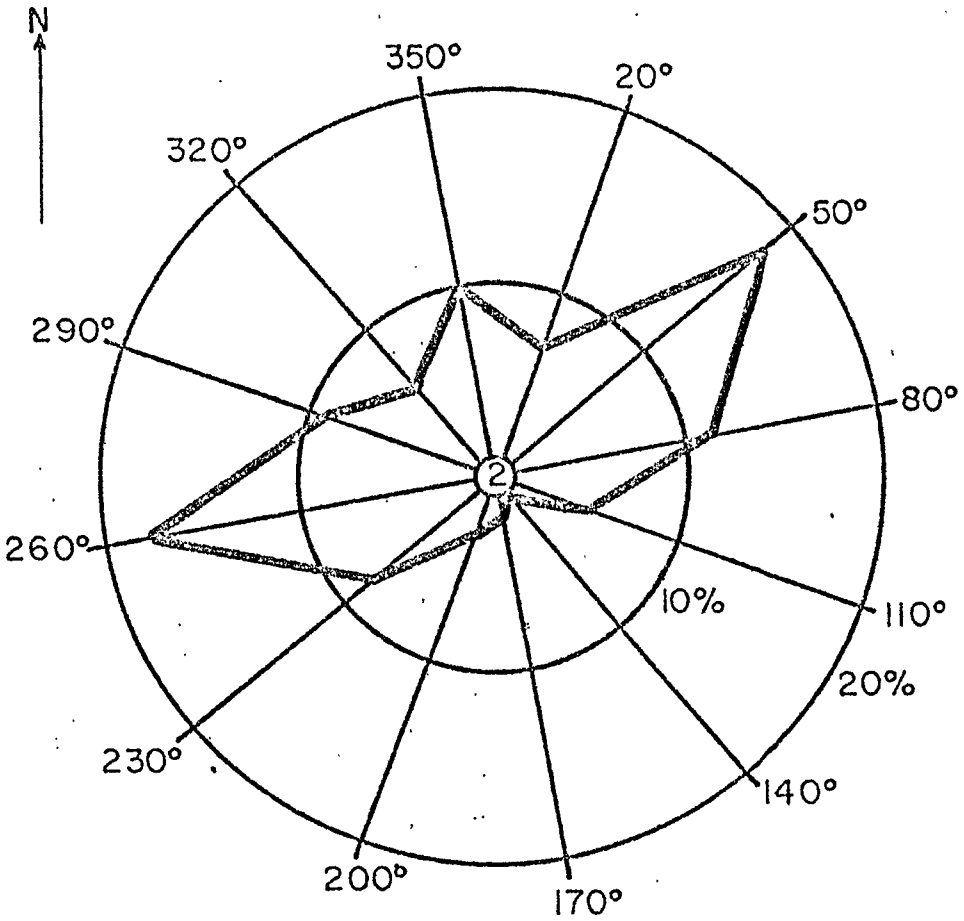


Figure 5. Ambient air asbestos survey, 1/26/76-2/27/76: asbestos levels near a manufacturer of molding compounds, 30-day average.

Figure 6. Ambient Air Asbestos Survey, 10/17/75-11/14/75: Asbestos Levels Near 3 Toll Plazas Along I-95, 30-Day Average





Frequency Distribution Of Wind Direction At Sikorsky Memorial Airport

Figure 6. Ambient air asbestos survey, 10/17/75-11/14/75: asbestos levels near 3 toll plazas along I-95, 30-day average.

Conclusions and Recommendations

Ambient asbestos levels in both rural and urban areas (removed from industrial users of asbestos) were relatively low (i.e., less than 10 ng/m^3) indicating that the "ambient asbestos problem" is limited to populations residing in close proximity to point sources of asbestos emissions. Ambient asbestos concentrations adjacent to several different industrial users of asbestos exceeded Connecticut's proposed asbestos air quality standard of 30 ng/m^3, 30-day average (i.e., 32 ng/m^3 - manufacturer of friction products; 33 ng/m^3 - manufacturer of insulated wire and cable and manufacturer of ammunition, located approximately 1/2 mile apart; 33 ng/m^3 - manufacturer of molding compounds) in spite of the fact that each source was in compliance with NESHAPS and other current applicable state and federal air quality regulations. Additional monitoring should be conducted to define month-to-month variations in ambient asbestos levels near these subject industrial users of asbestos, as well as other sources of asbestos emissions. Ambient asbestos levels at 3 toll plazas situated at various locations along I-95 were all relatively elevated (i.e., concentrations varied between 10 ng/m^3 and 25 ng/m^3) implicating vehicle brake lining decomposition as a significant source of airborne asbestos fibers. The highest measured asbestos concentration (i.e., 41 ng/m^3) for the entire survey was recorded at the monitoring site located adjacent to an urban toll station and one of the largest industrial users of asbestos in the State. Additional monitoring should be conducted near other toll plazas to better define the relationship between the number of vehicles/day passing through a toll station and ambient asbestos levels; data collected during the subject survey suggest a linear relationship. The quantity of asbestos fiber dust released during the demolition of structures containing asbestos floor and ceiling tile and/or which have been insulated or fireproofed with asbestos materials should be quantified as soon as possible. Furthermore, asbestos levels indoors should also be quantified in the near future, especially in buildings where asbestos surface coatings have been applied to walls, ceilings, exposed structural steel, air ducts, and plenums for insulating and/or decorating purposes.

Acknowledgements

Bill Torrey and John Courcier, Federal EPA - Region I for suppling NESHAP inspection reports; Philip Menchel and Arthur Fitzgibbons, Connecticut Department of Transportation for suppling traffic counts at the toll plazas along I-95; Paul Norton, Connecticut DEP, Air Compliance, Monitoring for preparing the necessary technical drawings; Rosanna Veilleux, Connecticut DEP, Air Compliance, Monitoring for her preparation of the manuscript; Ed Hyne, Connecticut DEP, Air Compliance, Monitoring for his expert assistance in conducting the subject survey.

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