AMBIENT ASBESTOS FIBER LEVELS IN THE METROPOLITAN AREAS OF NORFOLK - PORTSMOUTH - NEWPORT NEWS, VIRGINIA

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A B S T R A C T

Ambient asbestos fiber concentrations in the metropolitan areas of Norfolk - Portsmouth - Newport News, Virginia during the week of August 29 - September 2, 1983 were found to average 0.01 - 0.02 asbestos fibers/cubic centimeter (fibers/cc) of air, greater than 5 micrometers in length on an eight-hour time-weighted average as determined by phase contrast microscopy at 400X.

These data compare to previous published findings of 0.01 - 0.02 asbestos fibers/cc in Seattle and surrounding districts, to unpublished data from Bremerton, Washington and Portland, Oregon, and to data contained in the NIOSH "Revised Recommended Asbestos Standard of 1976".

This study indicates the importance of considering ambient "background" levels of airborne asbestos in the conduct and interpretation of occupational exposure studies involving products which may release very low levels of asbestos during handling, application or removal.

DISCLAIMER

The author is solely responsible for the contents and conclusions in this report, which may not necessarily reflect the official opinion of contributors, professional organizations, private affiliations or Federal and State agencies.

ACKNOWLEDGMENTS AND CONTRIBUTORS

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INTRODUCTION

In excess of 80 naturally occurring fibrous inorganic minerals are known to exist, approximately six of which are classified as asbestos. Asbestos is a generic term applied to several complex, hydrated and fibrous silicate minerals, falling into two broad mineralogical classifications: serpentines and amphiboles. Chrysotile is the only hydrated fibrous silicate asbestos mineral of serpentine origin. All other species of asbestos minerals (anthophyllite, actinolite, tremolite, crocidolite and amosite) are categorized in the amphibole group of minerals (1, 4, 12, 17, 19).

The various forms of asbestos have two very valuable characteristics in comon: they are heat and fire resistant. These special properties account for the extensive use of asbestos in insulative materials and furnaces, structural elements, ovens, hot pipes, electrical wiring and in such products as brake linings and clutch plates where high frictional heats are encountered. As these products wear out, weather, deteriorate or are deliberately removed, fine asbestos fibers and fibrils are released to the surrounding atmosphere as suspended particulates to be acted upon by air currents (5, 9, 14, 24, 37).

DISCUSSION

NIOSH (19) reported that in 1965, approximately 74 percent of the asbestos produced in the United States was used in the construction industry (532,300 tons) while 26 percent was used in non-construction industries (187,400 tons). Lanting and den Boeft (22) indicated that the total release of asbestos from its technical use into the atmosphere of the United States is about 2,093 metric tons per year (1974 estimate), being only 0.004 percent of all asbestos released to the environment (air, water, land). According to Robock (20), sources of ambient asbestos fiber contamination can occur from the following:

- Erosion of surface occurrences of asbestos (mountains, arable soils, etc.)
- Open cast mining
- Milling of asbestos (crushing of rocks, milling and sorting)
- Transport of asbestos
- Filter devices at manufacture of asbestos products
- Application of raw asbestos (e.g. - spray insulation)
- Application of products (AC weathering, friction linings, textiles, insulations, road coverings, household appliances, etc.)
- Demolition of asbestos-containing products (insulation, AC material, etc.)
- Waste disposal and dumps

Rohl, Langer and Selikoff (14) revealed another significant source of ambient asbestos contamination as disintegrated brake linings, most especially in brake repair shops and around highway/bridge/tunnel toll booths. Nicholson and Pundsack (32) reported in 1973 at the International Agency for Research on Cancer the existence of fugitive asbestos emissions escaping to the ambient atmosphere from the manufacture of asbestos products, vehicle brakes and clutches and building insulation, pointing up the variety of potential sources of asbestos contamination.

By assuming that spray application of asbestos was common practice in the period of 1958-1973 and that fireproofing of building interiors was the major use of this material, one may estimate the total amount used over this time frame to be 500,000 tons. Certainly this represents a major, if not the major, source of urban environmental asbestos contamination since buildings must be periodically demolished and/or remodeled (24).

As evidence that significant proportions of the general population have asbestos exposure, even though they were not working in occupations involving asbestos exposure, Selikoff (38) found that it was common for asbestos bodies to be present in lung tissue upon autopsy of New York residents. Since such individuals did not work with asbestos, they must have inhaled the asbestos from products or sources in their environment (3). Utilizing the sophisticated techniques of electron microprobe analysis, selected area diffraction and transmission electron microscopy, Langer, et al. (39) studied lung tissue at autopsy for New York City residents and found chrysotile asbestos regularly. Similar observations have been made by Pooley and colleagues (40) in England. Craighead and Mossman (27) reported that although ferruginous bodies (protein covered fibers present in the lungs) have been shown to form from foreign inorganic and organic fibers of many different types, ferruginous bodies in most human lungs have asbestos as a core. Furthermore, correlation between the extent of asbestos disease and number of asbestos bodies or total fiber content of the lungs has been difficult although fibrosis is usually evident when 1×10^6 fibers per gram of lung (wet basis) are present. Churg and Warnock (10) found concentrations of asbestos bodies in the lungs of women and white collar men fewer than 100 asbestos bodies/gram of wet lung, a level not accounted for by any exposures other than environmental or incidental ambient exposures. The bulk of these fibers was less than five micrometers in length. In a 1980 follow-up study, Churg and Warnock (15) reported that of 21 subjects examined and found to have asbetos fibers in their lungs, all subjects save three had none or very insignificant interstitial fibrosis. The three with marked fibrosis all had clinical reasons for the findings, e.g. - old tuberculosis. In sum, there appears to be little clear or striking evidence that continued asbestos inhalation at levels encountered in an urban environment for the general population gives rise to any significant identified asbestos-related disease (3, 15, 26, 27, 31, 35, 36, 38, 39).

Prior to November 4, 1983, the Federal Occupational Safety and Health Administration (OSHA) standard on Asbestos (CFR 1910.1001) was 2 fibers/cc greater than five micrometers in length for an eight-hour time-weighted average (1, 5, 12, 13, 30). Since November 4, 1983 and notwithstanding the Asbestos Information Association lawsuit effecting a temporary stay of implementation, the Federal OSHA Asbestos Standard has been modified according to the Federal Register (21) Emergency Temporary Standard downwards to 0.5 fiber/cc greater than five micrometers in length for an eight-hour time-weighted average. The method of sampling and analysis associated with the asbestos standard is that described in NIOSH P&CAM 239 "Asbestos Fibers in Air" (30), wherein fibers collected on a filter medium (18) are counted using a phase contrast microscope at 400-430X magnification. When one considers the non-occupational environment, however, the methods of fiber determination in ambient air and water become more esoteric (scanning electron microscopy, electron microprobe analysis and transmission electron microscopy) and significantly, much less related or even unrelated to the epidemiological evidence existing for populations exposed to asbestos (11). Environmental studies of ambient asbestos levels seem to focus more on gravimetric exposure (28, 32, 34) data than on airborne fiber

concentrations. Gravimetric asbestos exposure data, usually recorded in nanograms per cubic meter of air ($1 \times 10^{-9} gm/m^3$) are misleading since they: 1) do not relate to current epidemiology (11), 2) disregard other co-existing inorganic debris, 3) do not determine actual human exposures by utilizing samples collected in the "breathing zone" and 4) do not offer any consistent relationship with fiber counts obtained from phase contrast microscopy or, for that matter, fiber counts obtained with scanning electron microscopy following a 3:1 aspect ratio guideline (1, 6, 7, 9, 11, 20, 28, 29, 32, 34).

In 1973, Nicholson (32) attempted to draw a relationship between the concentrations of asbestos fibers in air expressed in nanograms of asbestos per cubic meter of air and the fiber counts in fibers/cc of air as required by the Federal OSHA Asbestos Standard. The value most commonly accepted is:

$1000 ng/m^3$ = 0.03 asbestos fibers/cc, greater than five micrometers in length as counted by phase contrast microscopy

A 1974 study by Ayer (29) showed several orders of magnitude differences between fiber/mass ratios of asbestos processing plants and mills, making any attempt to apply a constant conversion factor between number of fibers and mass uncertain at best. Ayer, further states that:

- No universal ratios or factors for conversion of optical microscope results to elecron microscope results exist.
- No single factor for conversion of mass emissions to fiber emissions exists.

According to LeMoine (5), ambient asbestos fiber concentrations in the city of Seattle, including selected contiguous metropolitan areas and districts averaged 0.03 fibers/cc for industrial areas. Unpublished work from Mangold (8) revealed ambient asbestos fiber levels averaging 0.02 fibers/cc during dry summer days in July/August 1982 in Portland and Bremerton. NIOSH reports in its "Revised Recommended Asbestos Standard" of 1976 that only a few studies of ambient levels have been performed using phase contrast optical microscopy. These limited studies indicate ambient levels to be generally less than 0.01 fibers/cc greater than five micrometers in length and with some peak values as high as 0.03 fibers/cc greater than five micrometers in length (11). Data reported above for LeMoine, Mangold and NIOSH are comparable, having been collected similarly and counted by phase contrast microscopy at 400X (LeMoine's counts at 300X would probably increase if counted at 400X). Lanting and den Boeft (22) reported fiber concentrations in the ambient atmospheres of urban Frankfort, FRG, Dusseldorf, FRG and urban major cities in the Netherlands up to 0.02 fiber/cc, 0.01 fiber/cc and 0.01 fiber/cc, respectively. Unfortunately, it was not entirely clear whether these measurements utilized a phase contrast microscope or a scanning electron microscope.

Selikoff (38) discusses some recent findings uncovered in a four-year study that suggests lower levels of exposure to asbestos fibers in air do not give rise to classical asbestosis. The effort centered more on the etiology of asbestos-induced cancers and the risk factors of such at very low levels of ambient exposure. Ambient asbestos fiber contaminations are less likely to produce significant risks of asbestos-related cancers, except adjacent to asbestos processing facilities in the

predominant emission footprint where exposures are elevated. Even in the face of these findings, OSHA established the Asbestos Emergency Temporary Standard on November 4, 1983 which called for a workplace permissible limit of 0.5 fiber/cc greater than five micrometers in length for an eight-hour time-weighted average (21).

METHODS OF INVESTIGATION

For products that contain encapsulated or "locked-in" asbestos fibers, the establishment of ambient atmospheric asbestos levels becomes of paramount importance in dimensioning the true contribution of asbestos-containing products to an employee's asbestos exposure. Studies performed by LeMoine (5), Mangold (8) and studies reported by Nicholson (11) in the NIOSH "Revised Recommended Asbestos Standard" have revealed the existence of urban ambient asbetos levels in selected U.S. cities ranging from 0.01-0.03 fibres/cc. The concentrations of airborne asbestos fibers were collected at breathing zone levels during August 29, 1983 through September 2, 1983 in the Norfolk-Portsmouth-Newport News metropolitan areas to determine the eight-hour work day exposures to city dwellers. Data collected in this manner would then be directly comparable to previous findings of airborne asbestos fiber levels in urban settings.

Four (4) locations were selected in the Norfolk-Portsmouth-Newport News metropolitan areas to represent typical urban and key industrial area exposures. Weather conditions experienced during the week of August 29, 1983 were fairly typical for the area at this time of the year: hot (range 70 to 88 degrees F), partly cloudy, occasional thunderstorms, fog, light rain, humid (75-85 percent RH) and light winds. With the exception of Friday's (September 2) data set, which experienced a shortened sampling time owing to rain, the samples were in accordance with the standard sampling methods required by the Federal Asbestos Standard, 29 CFR 1910.1001 (13) for a full eight hours at two liters per minute. Aerosol-type Millipore filters MAW P037AO, 0.8 micrometers pore size, in an open-faced 37 millimeter cassette were used to collect the asbestos fibers (18, 30). The samples were then prepared and counted by phase contrast microscopy at 400X according to requirements of the Federal Asbestos Standard (2, 4, 12, 13, 17, 21).

Methods, equipment and techniques employed in the measurement of city dweller's peak ambient asbestos levels in the Norfolk-Portsmouth-Newport News metropolitan areas were exactly the same as used to evaluate exposures to very low levels of asbestos in the workplace by the Federal Asbestos Standard. Each of the samples was collected for the eight hour workday period at breathing zone levels above the street surface(s). For these reasons, direct comparisons may be made between the known actual workplace release of asbestos fibers in working with encapsulated asbestos products and the exposures experienced by the general public in cities for which there is no significant impact on their health (3, 32, 36, 39, 40).

Samples of street dirt were collected at each sampling site (from the street surface, not curbside accumulations) in the Norfolk-Portsmouth-Newport News metropolitan areas to positively identify the existence of fallen asbestos fibers available for redispersion. A wisk broom was divided into quarters and each quarter broom used only at one site to avoid any possible cross-contamination of bulk street dirt samples. Furthermore, the street dirt samples were collected after each air sampler had been turned off at the end of the eight-hour period to preclude introduction of a sampling artifact.

FINDINGS

Ambient concentrations of asbestos fibers found at four (4) sampling sites in the metropolitan areas of Norfolk-Portsmouth-Newport News, Virginia during the week of August 29, 1983 - September 2, 1983 are summarized in Table VII. The ambient asbestos fiber concentrations in fibers/cc of air, greater than five micrometers in length averaged 0.01-0.02 fibers/cc, depending upon location (23). Levels comparable to these were reported for the cities of Seattle, Bremerton and Portland and by NIOSH for urban environs. Table VIII provides a comparison of asbestos fiber counts between the primary laboratory used for the phase contrast microscopic analysis and a laboratory certified by NIOSH as proficient in asbestos counting through participation in the national Proficiency Analytical Testing Program (23). As evidenced by the data in Table VIII, agreement between the laboratories was excellent.

Tables I-V provide the day-to-day air sampling data summaries, including notes of particular significance to sampling locations. Table VI - Parts I-V lists the analytical results (expressed as airborne asbestos fibers per cubic centimeter, greater than five micrometers in length) for the phase contrast microscopic readings at 400X for each daily set of samples collected. Appendix "A" includes the following locational descriptors: 1) a written description of each of the four sampling locations selected for the study, 2) photographs showing the sampling devices in place at each of the four sampling locations, and 3) copies of area street maps showing the precise locations of each of the four air sampling devices.

Based upon the results of this investigation in the Norfolk-Portsmouth-Newport News metropolitan areas, where contributions from natural sources (serpentine-containing rock formations) are felt minimal due to the geological characteristics of this region of Virginia, the ambient asbestos fiber concentrations likely originated with man-made sources (brakes, clutches, ship repair and rebuilding, sprayed on building insulations, transportation of asbestos wastes, etc.). For urban areas of the country where natural sources of asbestos could add significantly to that derived from man-made sources, one might anticipate ambient asbestos levels in excess of those reported in this study. Such areas as eastern Pennsylvania, southeastern New York, southwestern Connecticut, greater Los Angeles and the San Francisco area, would fall into this category (1).

CONCLUSIONS

Ambient air concentrations of asbestos fibers collected at breathing zone levels at four (4) locations within the Norfolk-Portsmouth-Newport News metropolitan areas during the eight-hour daytime work period for five consecutive days commencing August 29, 1983 revealed that:

A. City dwellers are exposed to an average of 0.01-0.02 asbestos fibers/cc, greater than five micrometers in diameter as determined by phase contrast microscopy at 400X.

B. The data summarized in Table VII demonstrate a consistent elevated airborne asbestos fiber to city dwellers in the Norfolk-Portsmouth-Newport News metropolitan areas during their eight-hour stay in ther city. City dwellers working in industrial areas were exposed to higher ambient asbestos fiber levels than city dwellers working in commercial areas/civic centers.

C. Since no firm scientific evidence of significant risk to the general public exists at these ambient asbestos levels based on asbestos disease incidence, then occupational or consumer exposures at or below these ambient asbestos fiber levels during processing of products containing encapsulated asbestos present a negligible risk of asbestos disease to users or handlers of such products.

D. With the November 4, 1983 promulgation of the OSHA Emergency Temporary Standard (ETS) on Asbestos of 0.5 fiber/cc greater than five micrometers in length for an eight-hour time-weighted average, ambient asbestos fiber concentrations take on even greater significance. Ambient asbestos fiber levels of 0.01-0.02 fiber/cc now represent 2-4 percent, respectively, of the Federal eight-hour ETS on asbestos.

TABLE I

AIR SAMPLING DATA SUMMARY - MONDAY, AUGUST 29, 1983

LOCATION	START	STOP	TEMP.(A.M.)*	TEMP.(P.M.)	PUMP #	WIND DIRECTION	WIND VELOCITY, MPH.	CALIB.**(A.M.)/(P.M.)
"A"	0617	1458	74/23.3	86/30	4	NE	4-9	2.0 / 2.0
"B"	-	-	-	-	-	-	-	-
"C"	0708	1549	74/23.3	86/30	13	NE	4-9	2.0 / 1.9
"D"	0735	1556	74/23.3	86/30	11	NE	4-9	2.0 / 1.8
BLANK	-	-	-	-	-	-	-	-

* - Temperatures (A.M.) and (P.M.) are given as °F/°C
** - Calibration expressed in liters/min.

NOTES:
- Thunderstorms very heavy in Norfolk/Portsmouth/Newport News between 4.00 P.M. and 10:00 P.M. Sunday (8/28/83); heaviest rainfall since May.
- Street conditions dry at all three locations sampled; curbside accumulations damp; humid conditions (82-85% R.H.) persisted through Monday.

@ Location "A", a street sweeper (dry sweeper w/vacuum) passed by @ 6:13 A.M. (0613)

Location "B" omitted due to very late start time

@ Location "C", a truck was observed parked immediately next to sampling device - partially shielding sampler from street at 1:25 P.M. (1325)

Location "D" selected on a tree to be less conspicuous to heavy pedestrian traffic

TABLE II

AIR SAMPLING DATA SUMMARY - TUESDAY, AUGUST 30, 1983

LOCATION	START	STOP	TEMP.(A.M.)*	TEMP.(P.M.)	PUMP #	WIND DIRECTION	WIND VELOCITY, MPH.	CALIB.**(A.M.)/(P.M.)
"A"	0606	1502	72/22.2	82/27.8	9	N	5-10	2.0 / 1.9
"B"	0847	1701	74/23.3	83/28.3	14	N	5-10	1.9 / 1.9
"C"	0700	1605	72/22.2	82/27.8	13	N	5-10	2.0 / 1.9
"D"	0751	1600	73/22.8	83/28.3	2	N	5-10	2.0 / 1.9
BLANK	-	-	-	-	-	-	-	-

* - Temperatures (A.M.) and (P.M.) are given as °F/°C
** - Calibration expressed in liters/min.

NOTES: • Street conditions dry @ all locations; curb accumulations dry; humidity still high (83% R.H.)

• Morning weather characterized by fog; later by broken clouds and sunshine

@ Location "C", a Wackenhut security guard (from United Virginia Bank Employee parking lot) indicated that a number of passersby expressed concern that the pump was a "bomb"

Location "D" attracted sufficient attention to cause some shipyard employees to blow smoke into the filter

TABLE III

AIR SAMPLING DATA SUMMARY - WEDNESDAY, AUGUST 31, 1983

LOCATION	START	STOP	TEMP.(A.M.)*	TEMP.(P.M.)	PUMP #	WIND DIRECTION	WIND VELOCITY, MPH.	CALIB.***(A.M.)/(P.M.)
"A"(1)**	0627	1437	72/22.2	88/31.1	9	S/SE	10	2.0 / 1.9
"A"(2)	0627	1437	72/22.2	88/31.1	2	S/SE	10	2.0 / 1.9
"B"	0923	1714	82/27.8	86/30	14	S/SE	10	2.0 / 1.9
"C"(1)	0718	1553	75/23.9	87/30.6	4	S/SE	10	2.0 / 1.9
"C"(2)	0718	1553	75/23.9	87/30.6	12	S/SE	10	2.0 / 1.9
"D"	0813	1625	77/25.0	87/30.6	13	S/SE	10	2.0 / 1.9
BLANK	-	-	-	-	-	-	-	-

* - Temperatures (A.M.) and (P.M.) are given as °F/°C

** - "A"(1) and (2) and "C"(1) and (2) are duplicates, to ascertain variability and precision in contiguous samplers

*** Calibration expressed in liters/min.

NOTES:
- @ Location "A", crews were mowing lawns at City Hall - 10:05 A.M. (1005)
- Weather characterized by sunshine and continued humidity (80% R.H.); clouds forming in sky by mid-afternoon

TABLE IV

AIR SAMPLING DATA SUMMARY - THURSDAY, SEPTEMBER 1, 1983

LOCATION	START	STOP	TEMP.(A.M.)*	TEMP.(P.M.)	PUMP #	WIND DIRECTION	WIND VELOCITY, MPH.	CALIB.**(A.M.)/(P.M.)
"A"	0623	1437	70/21.1	82/27.8	9	NE	10	2.0 / 2.0
"B"	0902	1734	71/21.7	81/27.2	11	NE	10	2.0 / 1.9
"C"	0715	1639	71/21.7	81/27.2	2	NE	10	2.0 / 1.9
"D"	0813	1632	72/22.2	81/27.2	13	NE	10	2.0 / 2.0
BLANK	-	-	-	-	-	-	-	-

* - Temperatures (A.M.) and (P.M.) are given as °F/°C

** - Calibration expressed in liters/min.

NOTES:

- Thunderstorms occurred on Wednesday night (8/31/83)
- Interviewed by Norfolk police @ Location "A" at 6:24 - 6:27 A.M. (0624-0627) - curious to the nature of this author's activities
- Streets dry, but curbside accumulations damp; all curbside accumulations dried out by afternoon, however
- @ Location "D", City Works employees working on sewer @ 11:10 A.M. (1110); gutter filled with water; truck backed up very close to air sampler

  Location "D" attracted sufficient attention to cause tampering by passersby (smoke on filter)

TABLE V

AIR SAMPLING DATA SUMMARY - FRIDAY, SEPTEMBER 2, 1983

LOCATION	START	STOP	TEMP.(A.M.)*	TEMP.(P.M.)	PUMP #	WIND DIRECTION	WIND VELOCITY, MPH.	CALIB.**(A.M.)/(P.M.)
"A"	0642	1338	71/21.7	74/23.3	9	NE	10-15	2.0 / 1.9
"B"	0913	1353	72/22.2	74/23.3	12	NE	10-15	2.0 / 2.0
"C"	0729	1447	72/22.2	76/24.4	4	NE	10-15	2.0 / 2.1
"D"	0824	1442	73/22.8	76/24.4	14	NE	10-15	2.0 / 2.0
BLANK	-	-	-	-	-	-	-	-

* - Temperatures (A.M.) and (P.M.) are given as °F/°C

** - Calibration expressed in liters/min.

NOTES:
- @ Location "A", street sweeper passed by with considerable visible dust in evidence
- Rain began in Norfolk/Portsmouth @ 1:15 P.M. (1315)
  Tests @ these sites ("A" and "B") terminated within 40 minutes thereafter
- Rain began in Newport News @ 2:25 P.M. (1425) tests @ Sites "C" and "D" terminated within 25 minutes thereafter

TABLE VI - PART I

AIRBORNE CONCENTRATIONS OF ASBESTOS FIBERS EXPRESSED AS FIBERS PER CUBIC CENTIMETER (FIBERS/CC), GREATER THAN 5 MICROMETERS IN LENGTH COUNTED BY PHASE CONTRAST MICROSCOPY AT 400X

LOCATIONS IN THE STATE OF VIRGINIA

DAY DATE	LOCATION	NET ASBESTOS FIBER COUNT	AIR SAMPLED, LITERS	ASBESTOS FIBERS PER CC, GREATER THAN 5 MICROMETERS IN LENGTH (rounded to hundredths)	REMARK
Monday 8/29/83					
M-"A"	City Hall, Norfolk, VA.	0.04	1042	0.01	(0.008
M-"B"	Portsmouth Naval Shipyard	(sample not collected; time constraints)			
M-"C"	City Hall, Newport News, VA.	0.05	1042	0.01	(0.01(
M-"D"	Newport News Shipyard	0.10	1042	0.02	(0.02
M-BLANK		0.00	-	-	-

* - Values actually calculated mathematically from asbestos fiber counts and air volume sampled in liters; however, the third decimal place is not significant and should be rounded to nearest hundredth as reported in the preceding column

TABLE VI - PART II

AIRBORNE CONCENTRATIONS OF ASBESTOS FIBERS EXPRESSED AS FIBERS PER CUBIC CENTIMETER (FIBERS/CC), GREATER THAN 5 MICROMETERS IN LENGTH COUNTED BY PHASE CONTRAST MICROSCOPY AT 400X

LOCATIONS IN THE STATE OF VIRGINIA

DAY DATE	LOCATION	NET ASBESTOS FIBER COUNT	AIR SAMPLED, LITERS	ASBESTOS FIBERS PER CC, GREATER THAN 5 MICROMETERS IN LENGTH (rounded to hundredths)	REMARK
Tuesday 8/30/83					
Tu-"A"	City Hall, Norfolk, VA.	0.04	1072	0.01	(0.008
Tu-"B"	Portsmouth Naval Shipyard	0.12	938	0.03	(0.028
Tu-"C"	City Hall, Newport News, VA.	0.02	1090	0.00	(0.004
Tu-"D"	Newport News Shipyard	0.07	978	0.02	(0.016 2 fibers 10 μ and μ observ
Tu-Blank		0.00	-	-	-

* - Values actually calculated mathematically from asbestos fiber counts and air volume sampled in liters; however, the third decimal place is not significant and should be rounded to nearest hundredth as recorded in the preceding column

- Two fibers observed on the filter from the Newport News Shipyard sampling site "D" were found to be 10 μ and 25 μ, respectively. The size of these asbestos fibers strongly suggest that the genesis is insulative materials from the shipyards, since fibers from brakes are much shorter.

TABLE VI - PART III

AIRBORNE CONCENTRATIONS OF ASBESTOS FIBERS EXPRESSED AS FIBERS PER CUBIC CENTIMETER (FIBERS/CC), GREATER THAN 5 MICROMETERS IN LENGTH COUNTED BY PHASE CONTRAST MICROSCOPY AT 400X

LOCATIONS IN THE STATE OF VIRGINIA

DAY DATE	LOCATION	NET ASBESTOS FIBER COUNT	AIR SAMPLED, LITERS	ASBESTOS FIBERS PER CC, GREATER THAN 5 MICROMETERS IN LENGTH (rounded to hundredths)	REMARKS*
Wednesday, 8/31/83					
W-"A"(1)	City Hall, Norfolk, VA.	0.04	980	0.01	(0.009)
W-"A"(2)	City Hall, Norolk, VA.	0.03	980	0.01	(0.007)
W-"B"	Portsmouth Naval Shipyard	0.07	942	0.02	(0.016)
W-"C"(1)	City Hall, Newport News, VA.	0.03	1030	0.01	(0.008)
W-"C"(2)	" "	0.04	1030	0.01	(0.009)
W-"D"	Newport News Shipyard	0.06	984	0.01	(0.013)
W-BLANK		0.00	-	-	-

* - Values actually calculated mathematically from asbestos fiber counts and air volume sampled in liters; however, the third decimal place is not significant and should be rounded to nearest hundredth as recorded in the preceding column.

TABLE VI - PART IV

AIRBORNE CONCENTRATIONS OF ASBESTOS FIBERS EXPRESSED AS FIBERS PER CUBIC CENTIMETER (FIBERS/CC), GREATER THAN 5 MICROMETERS IN LENGTH COUNTED BY PHASE CONTRAST MICROSCOPY AT 400X

LOCATIONS IN THE STATE OF VIRGINIA

DAY DATE	LOCATION	NET ASBESTOS FIBER COUNT	AIR SAMPLED, LITERS	ASBESTOS FIBERS PER CC, GREATER THAN 5 MICROMETERS IN LENGTH (rounded to hundredths)	REMARKS
Thursday, 9/1/83					
Th-"A"	City Hall, Norfolk, VA.	0.04	988	0.01	(0.009)
Th-"B"	Portsmouth Naval Shipyard	0.09	1024	0.02	(0.019)
Th-"C"	City Hall, Newport News, VA.	0.01	1128	0.00	(0.002)
Th-"D"	Newport News Shipyard	0.05	998	0.01	(0.011) Smoke on filt
Th-Blank		0.00	-	-	-

* - Values actually calculated mathematically from asbestos fiber counts and air volume sampled in liters; however, the third decimal place is not significant and should be rounded to nearest hundredth as recorded in the preceding column

- Lower Limit of Detection (LLD) for sample Th-"C" @ 0.002 fibers/CC, greater than 5 micrometers in length

- Sample Th-"D" from Newport News Shipyard sampling site had considerable smoke on the filter, probably a deliberate tampering by passersby - also seen to lesser extent at this site on Tuesday (August 30)

TABLE VI - PART V

AIRBORNE CONCENTRATIONS OF ASBESTOS FIBERS EXPRESSED AS FIBERS PER CUBIC CENTIMETER (FIBERS/CC), GREATER THAN 5 MICROMETERS IN LENGTH COUNTED BY PHASE CONTRAST MICROSCOPY AT 400X

LOCATIONS IN THE STATE OF VIRGINIA

DAY DATE	LOCATION	NET ASBESTOS FIBER COUNT	AIR SAMPLED, LITERS	ASBESTOS FIBERS PER CC, GREATER THAN 5 MICROMETERS IN LENGTH (rounded to hundredths)	REMARKS*
Friday, 9/2/83					
P-"A"	City Hall, Norfolk, VA.	0.02	832	0.00	(0.005)
P-"B"	Portsmouth Naval Shipyard	0.05	560	0.02	(0.019)
P-"C"	City Hall, Newport News, VA.	0.02	876	0.00	(0.005)
P-"D"	Newport News Shipyard	0.06	756	0.02	(0.017)
P-Blank		0.00	-	-	-

* - Values actually calculated mathematically from asbestos fiber counts and air volume sampled in liters; however, the third decimal place is not significant and should be rounded to nearest hundredth as recorded in the preceding column.

TABLE VII

SUMMARY OF AMBIENT CONCENTRATIONS OF ASBESTOS FIBERS FOUND AT FOUR (4) SAMPLING SITES IN THE METROPOLITAN AREAS OF NORFOLK - PORTSMOUTH - NEWPORT NEWS, VIRGINIA DURING WEEK OF AUGUST 29-SEPTEMBER 2, 1983

SAMPLING SITES	AIRBORNE ASBESTOS FIBER CONCENTRATIONS, EXPRESSED AS FIBERS PER CUBIC CENTIMETER, GREATER THAN 5 MICROMETERS IN LENGTH* MONDAY(8/29)	TUESDAY(8/30)	WEDNESDAY(8/31)	THURSDAY(9/1)	FRIDAY(9/2)	AVE.	RANGE FIBERS/(
"A"	0.01	0.01	0.01 0.01	0.01	0.00	0.01	0.00-0.((0.005 - 0.009)
"B"	-	0.03	0.02	0.02	0.02	0.02	0.02-0.((0.016 - 0.028)
"C"	0.01	0.00	0.01 0.01	0.00	0.01	0.01	0.00-0.((0.002 - 0.010)
"D"	0.02	0.02	0.01	0.02	0.02	0.02	0.01-0.((0.011 - 0.021)

* - Lower Limit of Detection = 0.002 fibers/cc, greater than 5 micrometers in length

NOTE: Samples of street dirt collected at each site (from street surface, not curbside accumulations) were examined under the microscope for evidence of fallen asbestos fibers. All samples contained asbestos fibers, although no attempt was made to size the fibers. Microscopic examination revealed more asbestos fibers in street dirt collected adjacent to the two shipyards.

TABLE VIII

COMPARISONS OF ASBESTOS FIBER COUNTS BETWEEN LABORATORY # 1 AND LABORATORY # 2 ON SIX (6) SELECTED SAMPLE FILTERS

SAMPLE	LABORATORY # 1 (Primary Lab.)	LABORATORY # 2
T-"D"	0.07 fibers	0.04 fibers
W-"A"(1)	0.04 "	0.04 "
W-"A"(2)	0.03 "	0.01 "
W-"B"	0.04 "	0.05 "
W-"C"(1)	0.03 "	0.02 "
W-"C"(2)	0.04 "	0.04 "

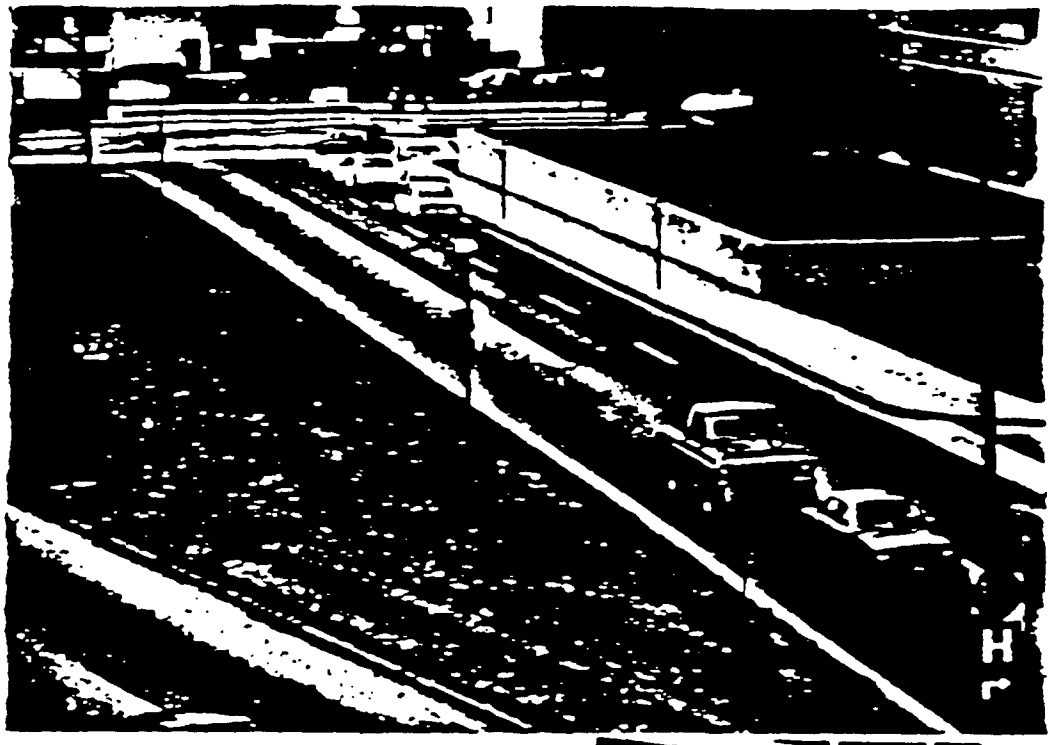
NOTE: All of the six (6) sample filters tested were corroborated as containing fibers on the filters and fiber counts per 100 fields fell within the expected error range of the coefficient of variation of 0.41.

APPENDIX "A"

SAMPLING LOCATIONS AND LOCATION DESCRIPTIONS

LOCATION	DESCRIPTION
A	CITY HALL, NORFOLK Air sampling device mounted on a black light post immediately across Union Ave. from the main entrance of Norfolk City Hall. Air sampler located midway between Norfolk City Hall and main thoroughfare (Waterfront Dr.) alongside Union Ave. on the south side of the street.
B	NAVAL SHIPYARD, PORTSMOUTH Air sampling device mounted on a brown telephone pole approximately 27 meters southwest along Portsmouth Ave. from intersection of Portsmouth Ave. and 4th St. and entrance to Gate 10 of Portsmouth Naval Shipyard. Air sampler located 4 1/2 meters from concrete wall surrounding naval shipyard property boundaries.
C	CITY HALL, NEWPORT NEWS Air sampling device mounted on a green light post located at the entrance of the Newport News City Hall employee parking lot midway between Washington and West Avenues along 25th St. Air sampler located across street from United Virginia Bank employee parking lot, on southeast side of 25th St.
D	SHIPYARD, NEWPORT NEWS Air sampling device mounted on a maple tree located approximately midway between 41st St. and 42nd St. on the southwest side of Huntington Ave. Air samplerlocated about 1 block and across an employee parking lot from the main entrance to the Newport News Shipyard.

LOCATION "A" - CITY HALL, NORFOLK



Looking west along Union Ave. as seen from the Berkley Bridge. Air sampler is visible as black protuberance below the sign on the center lightpost.

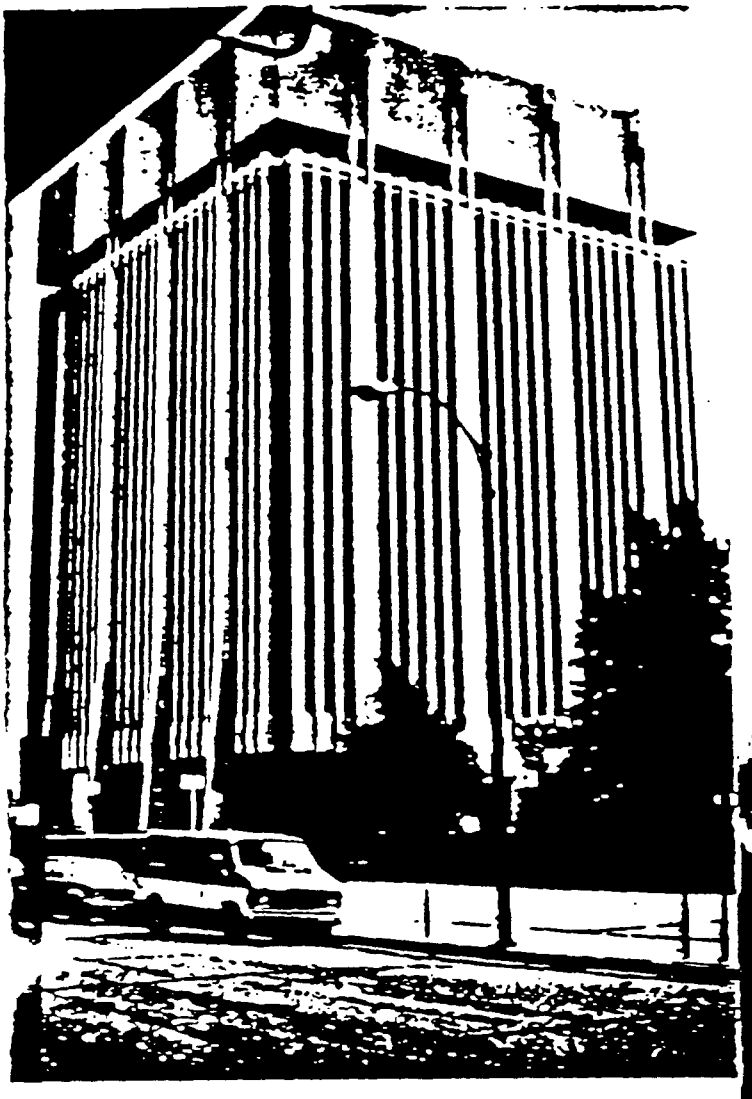
Photograph at right shows the air sampler on the light post in the foreground with the Norfolk City Hall in the background. Looking northeast across Union Ave.

LOCATION "B" - NAVAL SHIPYARD, PORTSMOUTH

Air sampler mounted on a telephone pole immediately outside the circum-naval shipyard wall along Portsmouth Ave. between 4th and 5th Streets.

Looking northeast along Portsmouth Ave. toward the 4th St. intersection and entrance to Gate 10 of the Naval Shipyard (flags located over gate). Air sampler located on the telephone pole in the foreground.

LOCATION "C" - CITY HALL, NEWPORT NEWS



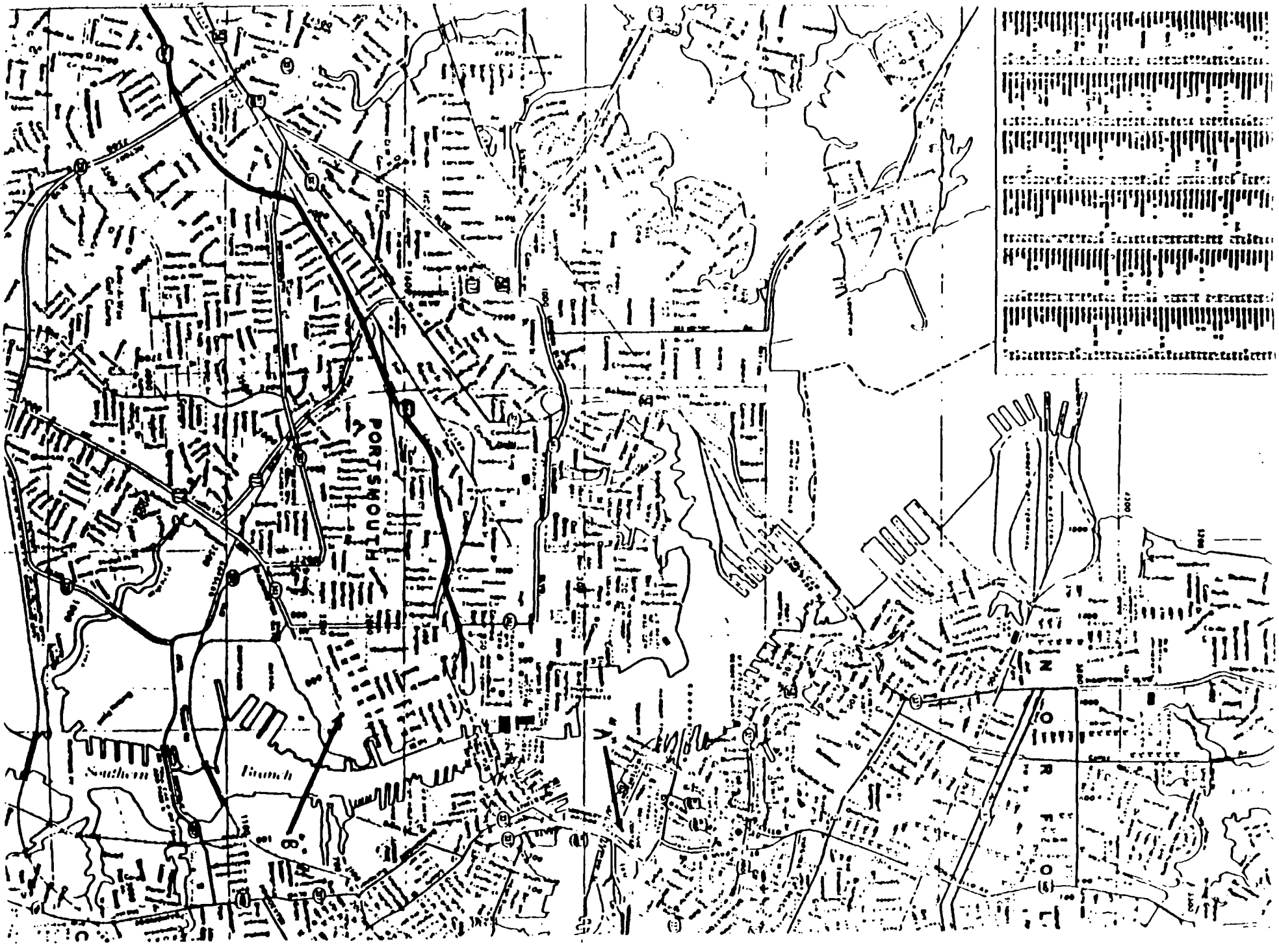
Looking east across 25th St. at the Newport News City Hall under cover of the United Virginia Bank employee parking lot. Air sampler is located on the green lightpost to the right of center.

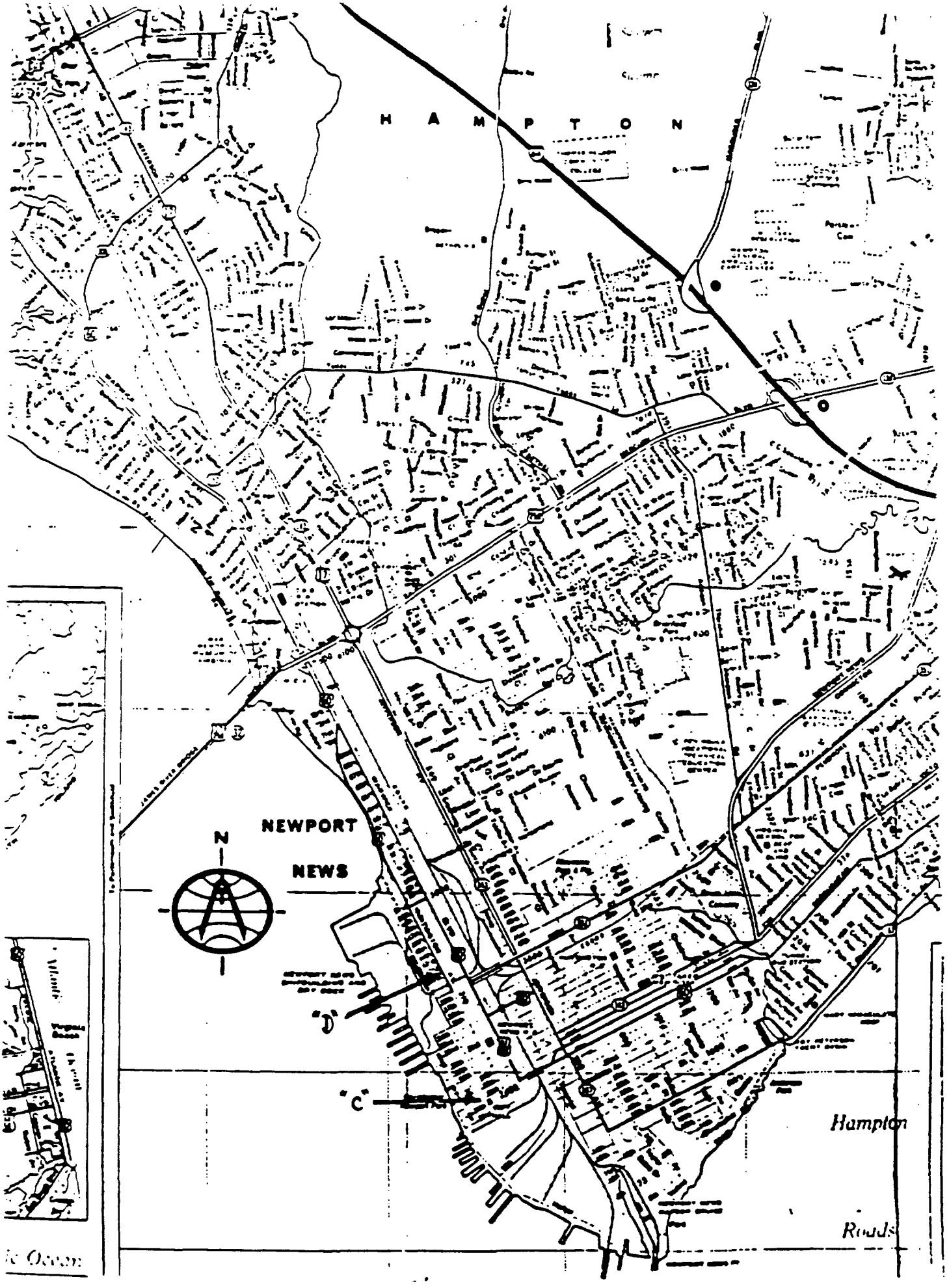
Air sampler mounted on a green lightpost alongside entrance to Newport News City Hall employee parking lot.

LOCATION "D" - SHIPYARD, NEWPORT NEWS

Looking southwest across Huntington Ave. between 41st & 42nd Streets toward main Newport News Shipbuilding office. Air sampler is located on small maple tree to the left of the sign post

Same shot as above but with telephoto lens. Note air sampler on maple tree to the left of the sign post. Newport News Shipbuilding office is in the background across employee parking lot.


PORTSMOUTH


H A M P T O N
N
NEWPORT
NEWS
"D"
"C"
Hampton
Roads

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Affidavit Of John E. Craighead, M.D.

State of Vermont)
) ss.:
County of _____

John E. Craighead, M.D., being duly sworn, deposes and says:

1. I am a medical doctor and currently Chairman of the Department of Pathology, University of Vermont in Burlington, Vermont. As a physician and pathologist, I have had extensive experience in experimental and diagnostic studies of diseases in man, including in recent years significant and continuing studies of asbestos associated diseases.

2. I have studied with great care a report entitled "The Actual Contribution of Garlock Asbestos Gasket Materials to the Occupational Exposure of Asbestos Workers", dated October 1982, prepared by Carl A. Mangold.

3. I have reached the conclusion that the concentrations of asbestos in the working environment demonstrated by the experiments using Garlock material (as described in the Mangold Report) are insufficient to cause detectable disease in man by current standards and with our present state of knowledge.

John E. Craighead, M.D.

Sworn to before me this 18th day of October, 1983.

Notary Public