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Project Summary

AHERA Clearance at Twenty Abatement Sites

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A study was conducted to document the use of the Asbestos Hazard Emergency Response Act's (AHERA) clearance sampling practices and to assess final clearance concentrations of asbestos at 20 abatement sites. Consultants who conducted the clearance air monitoring did not completely understand and follow the AHERA sampling and analytical requirements and recommendations. According to clearance results reported by the Asbestos Safety Control Monitor (ASCM) firms employed by the building owners, all 20 abatement sites ultimately passed AHERA clearance. The AHERA clearance concentrations measured independently by the U.S. Environmental Protection Agency (EPA) and the New Jersey Department of Health (NJDOH), however, showed that 12 of the 20 abatement sites would have failed AHERA clearance had the data of these two agencies been used.

This Project Summary was developed by EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

As required under the AHERA of 1986, the EPA has promulgated a final rule regarding inspections, abatement, and management of asbestos-containing materials (ACM) in schools (40 CFR Part 763). The rule describes procedures for determining when critical containment barriers can be removed.

After the abatement work site has passed a thorough visual inspection, clearance air monitoring is conducted. Before the air monitoring is begun, floors, walls, and ceilings should be swept with the exhaust of a 1-hp (minimum) leaf blower. Stationary fans, with the air directed towards the ceiling, must be used to provide continuous air circulation in the workplace. In most cases, air monitoring samples are analyzed by transmission electron microscopy (TEM). Air samples must be collected on 25-mm diameter filters either 0.4-μm (or smaller) pore-size polycarbonate or 0.45-μm (or smaller) pore-size mixed cellulose ester membrane filters contained in a three-piece cassette. For 25-mm filters, sampling rates between 1 and 10 L/min must be used to achieve a recommended air volume of 1200 to 1800 L. Under certain circumstances (depending on the size and nature of the abatement project), a site may be cleared by having the air samples analyzed by phase contrast microscopy (PCM).

The AHERA TEM clearance criterion is primarily comparative in nature; i.e., it is based on a comparison of airborne asbestos concentrations inside the abatement work area with those outside the abatement work area but not necessarily with concentrations from outside of the building. Outdoor samples are normally recommended, however, because they are less likely than indoor air samples to be affected by work practices that might contaminate other areas inside the building. The AHERA clearance test requires the

collection of at least five samples inside the abatement area and five samples outside of the area. A statistical test (the Z-test) is then used to determine if the average concentration inside the abatement area is higher than the average concentration outside the abatement area. If the Z statistic is less than or equal to 1.65, the site passes the clearance test and is considered acceptable for reoccupancy.

The AHERA Z-test is preceded by an initial screening test and a blank contamination test. The initial screening test compares the average filter concentration of the five samples collected inside the abatement area against a value of 70 structures per mm^2 (s/mm^2). If the average filter concentration is less than or equal to 70 s/mm^2, the work area passes the clearance test without analysis of the outside samples being required. If the work area samples do not pass the screening test, a minimum of three blanks (filters through which no air has been drawn) are analyzed to check for the possibility of filter contamination that would distort the test results.

A joint research effort by the EPA Office of Research and Development's Risk Reduction Engineering Laboratory (RREL) and the NJDOH was conducted during the summer of 1988 to document AHERA clearance air-sampling practices and clearance concentrations of airborne asbestos at 20 asbestos-abatement sites in New Jersey. Each abatement took place in a school building and involved removal of surfacing material, thermal system insulation, or suspended ceiling tiles.

Study Design and Methods

Site Selection

Although selection of the 20 asbestos-abatement projects was based largely on availability, each site also met the following criteria:

(1) Each abatement project was in a school building.

(2) The abatement project involved removal of one or more of the following: (a) sprayed- or troweled-on surfacing material; (b) thermal system insulation from mechanical equipment (i.e., boilers, tanks, heat exchangers, pipes, etc.); or (c) suspended ceiling panels.

(3) The abatement project was governed by written specifications prepared in compliance with the minimum requirements of the State of New Jersey Asbestos Hazard Abatement Subcode (N.J.A.C. 4:23-8) and EPA guidance for work practices and procedures to be used in performing asbestos-abatement projects.

(4) The abatement project was cleared in accordance with the sampling protocol specified in the AHERA final rule (40 CFR Part 763).

Site Documentation

At each site, background information describing the abatement area and the ACM abated and other miscellaneous information were obtained by interviewing an asbestos safety technician (AST) certified by the New Jersey Department of Community Affairs and employed by an ASCM firm. The ASCM firm was employed by the School District or Local Education Agency. The AST continuously monitored and inspected the asbestos-abatement project in accordance with the Asbestos Hazard Abatement Subcode (N.J.A.C. 5:23-8). The AST must be on the job site continuously during the abatement project to ensure that the work is performed in accordance with the regulations specified in the Asbestos Hazard Abatement Subcode.

The following information was gathered to document the AHERA clearance air-sampling practices used by the ASCM firm at each site:

(1) conditions of sampling, i.e., aggressive versus nonaggressive sampling and the use of circulating fans to maintain air circulation during clearance sampling,

(2) air sampling methods, i.e., filter medium, type of filter cassette, sampling rate, sample volume, and location of air samplers; and

(3) asbestos safety technician's project report on the onsite supervision and AHERA clearance air monitoring.

Air Sampling Strategy

As part of this present study, NJDOH/EPA collected preabatement air samples (1) in the perimeter area (i.e., outside the intended work area but inside the building) before the containment barriers were constructed and (2) outdoors to determine whether the abatement action significantly affected the airborne asbestos concentrations in these areas. The preabatement sampling was conducted under static conditions (i.e., activity in the area was minimal, and the heating, ventilation, and air-conditioning system was not operating). Preabatement sampling was possible at only nine sites because of difficulties encountered in identifying sites that met the selection criteria. At eight of the nine sites, five samples were collected both in the perimeter of the intended abatement work area and outdoors. At one site, three samples were collected in the abatement work area, two samples in the perimeter, and five samples outdoors. The configuration of the building and the areas specified for abatement necessitated collecting samples in the intended abatement area at this site.

Postabatement air samples were collected at the 20 abatement sites. Five area air samples were collected in each of three areas: the abatement work area, the perimeter, and outdoors. The samples were collected at approximately the same time and location (within a radius of 5 ft) as those collected by the AST for AHERA clearance of the site. In the abatement work area, samples were collected under the sampling conditions that existed during the final-clearance air sampling. The perimeter area samples were collected under static conditions.

In addition to analyses of the postabatement air samples collected by NJDOH/ EPA, analyses were also obtained of the postabatement clearance air samples collected by the ASCM firms. Clearance of each abatement site was based on the results of the latter analyses.

Sampling Methodology

NJDOH/EPA air samples were collected on open-face, 25-mm-diameter, 0.45-μm pore-size, mixed cellulose ester membrane filters with a 5-μm pore-size, mixed cellulose ester, backup diffusing filter and cellulose support pad contained in a three-piece cassette. The filter cassettes were positioned approximately 5 ft above the floor on tripods, with the filter face at approximately a 45° angle toward the floor. The filter assembly was attached to a 1/6-hp electric-powered vacuum pump operating at a flow rate of approximately 9 L/ min. The sampling pumps were calibrated with a precision rotameter both before and after sampling. A primary calibration standard was used to calibrate the precision rotameter in the field.

Analytical Methodology

The NJDOH/EPA mixed cellulose ester filters were prepared and analyzed in accordance with the nonmandatory TEM method, as described in the AHERA final rule (40 CFR 763). A sufficient number of grid openings were analyzed for each sample to ensure a sensitivity (the concentration represented by a single structure) of no greater than 0.005 asbestos s/cm^3 of air sampled. The specific length and width of each structure were also

measured and recorded. The Public Health and Environmental Laboratories of the NJDOH performed the TEM analyses on the field samples under a separate cooperative agreement with EPA's RREL in Cincinnati.

Statistical Analysis

The Wilcoxon Signed Rank test was used to evaluate differences in airborne asbestos concentrations before and after abatement. This nonparametric statistical procedure analyzes the relative ranks and magnitudes of the differences between paired data rather than analyzing the actual data values, and it requires fewer assumptions regarding the underlying statistical distribution of the data.

The AHERA Z-test was used to compare the final-clearance samples collected inside the abatement area with the samples collected outside the abatement work area (inside the building and outdoors).

Results and Discussion

Site Descriptions

Sixteen of the abatement projects involved general occupancy areas (classrooms, offices, recreational rooms, corridors, etc.); three involved boiler rooms and mechanical equipment rooms; and one involved both of these types of areas. At 13 of the project sites, the abated ACM consisted of surfacing material (acoustical plaster or fireproofing); at 3 sites, both surfacing material and thermal system insulation; and at 2 sites, suspended ceiling tiles. At 17 sites, the ACM contained chrysoltile asbestos (from 2% to 93%); at 2 sites, amosite asbestos (from 2% to 10%); and at 1 site, both chrysoltile (from 10% to 75%) and amosite (from 30% to 40%).

The abatement projects involved 11 different abatement contractors, 8 ASCM firms, and 5 TEM analytical laboratories.

Observed AHERA Clearance Practices

Aggressive Sampling

A 24-hour drying time is recommended before postabatement clearance air monitoring. Postabatement air monitoring should be conducted under aggressive sampling conditions. The abatement area floors, walls, ledges, ceiling, and other surfaces should be swept with the exhaust from forced-air equipment (e.g., a minimum 1-hp leaf blower) to dislodge any remaining dust, and stationary fans should be used to keep fibers suspended during sampling. Current guidance on asbestos-abatement work practices and procedures recommends aggressive air-sweeping of the abatement area for at least 5 min per 1000 ft^2 floor area. The AHERA rule recommends the use of at least one stationary fan per 10,000 ft^3 of workspace, with the air directed toward the ceiling to keep the asbestos fibers suspended during sampling.

At 8 of the 20 abatement sites, the ASCM firms allowed less than the EPA-recommended drying time of 24 hr after the completion of final cleaning before final clearance air monitoring was begun. The drying times for these eight sites ranged from 2 to 18 hr.

At 19 of the 20 abatement sites, aggressive sampling techniques were used. At 14 of these 19 sites, the recommended aggressive air-sweeping rate of at least 5 min per 1000 ft^2 of floor area was not achieved.

At only 12 of the 20 sites were stationary air fans used to maintain air circulation during clearance air sampling. Box-type fans were used at nine of these sites, and pedestal-type fans were used at three sites. At 15 of the observed sites, the ASCM firm failed to use the number of fans per given volume of workspace required by AHERA.

Filter Types

The ASCM firms used mixed cellulose ester membrane filters to collect clearance air samples at 14 of the 20 observed abatement sites. Polycarbonate membrane filters were used at six sites. The AHERA rule permits the use of either filter type; however, the pore-size must be less than or equal to 0.45μm for mixed cellulose ester filters and 0.4 μm for polycarbonate filters. At three sites, 0.8-μm pore-size mixed cellulose ester membrane filters were used to collect clearance air samples; this did not comply with the AHERA regulations. All filters used for clearance air monitoring were 25 mm in diameter and were contained in three-piece cassettes with a 50-mm extension cowl.

Flow Rates and Air Volumes

Each filter assembly was attached to an electric-powered pump operating at a specified airflow rate. The air samples were generally collected for a set length of time to achieve a certain minimum air volume. The AHERA rule states that pump flow rates between 1 and 10 L/min may be used for 25-mm-diameter filters. The ASCM firms practiced this at 18 of the 20 sites observed. At two sites, air samples were collected at flow rates greater than 10 L/min. Air volumes ranged from 1320 to 4161 L for the postabatement air samples collected inside and outside the abatement area at the observed sites. The AHERA rule recommends sampling between 1200 and 1300 L of air for 25-mm-diameter filters.

Analytical Methods

At 18 of the 20 observed sites, the laboratory reports indicated that the ASCM firms' final clearance air samples were analyzed by TEM in accordance with either the mandatory or nonmandatory TEM methods described in AHERA. At two sites, PCM was used to analyze the clearance air samples. Although the samples were reportedly analyzed in accordance with NIOSH Method 7400 at these two sites, improper filters (for this method) were used to collect the clearance samples (0.4-μm pore-size polycarbonate filters instead of the 0.8-μm pore-size mixed cellulose ester filters specified in NIOSH Method 7400).

AHERA Clearance Tests

Two sets of data were collected: (1) data collected and analyzed by the ASCM firms and their contract laboratories (which were used to declare the site clean and to release the abatement contractor); and (2) data collected and analyzed independently by NJDOH/EPA.

ASCM Sample Analyses

Two of the 20 sites were cleared as the result of ASCM-firm data analyzed by PCM. During the period when the TEM analyses were being phased in, AHERA permitted the use of PCM for clearance of removals involving 3000 ft^2 or less of ACM. At least five samples were required inside the abatement area, and the fiber concentration of each had to be below the limit of reliable quantitation (0.01 f/cm^3 for NIOSH Method 7400) to pass the clearance criterion. Clearance as the result of PCM analyses was permitted at one site because the removal involved approximately 2200 ft^2 of ACM; however, the single sample used to clear the site was not sufficient. AHERA requires a minimum of five samples for clearance with the use of PCM. One site, which involved the removal of approximately 5300 ft^2 of ACM, was cleared as the result of PCM analysis of two samples even though TEM clearance was required. The other 18 sites were cleared based on the results of the initial screening test.

NJDOH/EPA Sample Analyses

Table 1 summarizes the results of the AHERA initial screening test and the AHERA Z-test for each abatement site, based on the NJDOH/EPA samples.

Table 1. Summary of AHERA Initial Screening Test and AHERA Z-Test Results From Samples Collected by the New Jersey Department of Health/U.S. Environmental Protection Agency

	Mean Concentration, s/cm³ (5 samples)			AHERA Clearance Test Results		
Site	Abatement Area	Perimeter	Outdoor	Initial Screening	Z-Test with Perimeter	Z-Test with Outdoor
A	0.002	0.001	0	Pass	Pass	Pass
B	0.016	0.008	0.001	Fail	Pass	Fail
C	0.060	0.002	0.004	Fail	Fail	Fail
D	0.079	0.062	0.052	Fail	Pass	Pass
E	0	0	0	Pass	Pass	Pass
F	0.024	0.002	0.001	Fail	Fail	Fail
G	0.007	0.010	0	Pass	Pass	Pass
H	0.016	0.062	0.003	Fail	Pass	Pass
I	0	0	0.006	Pass	Pass	Pass
J	0.004	0.001	0.001	Pass	Pass	Pass
K	0.063	0.008	0	Fail	Fail	Fail
L	0.118	0.066	0.004	Fail	Fail	Fail
M	0.322	0.002	0.002	Fail	Fail	Fail
N	0.100	0.003	0.004	Fail	Fail	Fail
O	0.004	0.003	0.001	Pass	Pass	Pass
P	0.005	0.007	0.003	Pass	Pass	Pass
Q	0.099	0.055	0.007	Fail	Fail	Fail
R	0.002	0	0	Pass	Pass	Pass
S	0.012	0.003	0	Fail	Pass	Fail
T	0.049	0.030	0.015	Fail	Fail	Fail

Twelve of the 20 sites would have failed the initial screening test had the samples collected by NJDOH/EPA been used. (In contrast, all 18 sites for which TEM analysis was used by the ASCM firms for clearance passed the initial screening test and were cleared for reoccupancy.) Ten of the 12 sites that would have failed the initial screening test had the NJDOH/EPA data been used would have subsequently failed the AHERA Z-test based on comparison with outdoor air samples. The other two sites would have passed the AHERA Z-test, primarily because of elevated levels of asbestos in the outdoor and perimeter air. The remaining eight sites would have passed both the initial screening test and the Z-test regardless of whether outdoor or perimeter levels were used in the Z-test comparison.

Choosing the perimeter area outside the work area but inside the building or the outdoor air as the "outside" reference point in the AHERA Z-test would have affected the outcome of the clearance comparison two sites. In each case, the site would have passed the Z-test if the perimeter values had been used in the comparison and failed if the outdoor levels had been used. The perimeter area outside the work area can be compromised by work practices that may contaminate other areas inside the building, by a breach in the critical barriers surrounding the work area, by the air-filtration systems (e.g., torn ductwork passing through adjacent building areas), or by preexisting ACM in the area. Outdoor samples are less likely to be affected by these conditions, and their use in the clearance comparison would generally provide a more stringent comparison.

Asbestos Concentrations Before and After Abatement

Preabatement samples were collected in the perimeter area and outdoors at nine sites. Overall, the trend toward higher concentrations of airborne asbestos after abatement was significant in both the perimeter and outdoor air ($p < 0.05$). The cause of elevated asbestos concentrations in the perimeter and outdoor air is unknown; however, conditions such as torn ductwork, improper seals on air filtration units, and breached containment were observed at several sites.

Conclusions

The principal conclusion during this study is that consultants who conduct clearance air monitoring often do not completely understand and follow the AHERA sampling and analytical requirements and recommendations.

Discrepancies existed between AHERA clearance concentration results of sample analyses reported by the ASCM firms employed by the building owner and those reported independently by NJDOH/EPA.

Making the choice between perimeter or outdoor samples as the "outside values" in the AHERA Z-test is critical in determining if an area is acceptable for occupancy. Analyses of NJDOH/EPA samples showed that two sites would have passed the AHERA Z-test if perimeter samples had been used as the "outside values" but would have failed had outdoor samples been used.

Although the general trend was toward statistically significant increases in asbestos concentrations after abatement (compared with preabatement concentrations at nine sites), only three of the seven apparent increases were statistically significant on an individual basis.

Recommendations

This study points up the need to develop a comprehensive guidance document that addresses the procedures and protocols of AHERA air monitoring. Im-

proper final clearance air monitoring resulted in part from a lack of understanding of AHERA air monitoring procedures. The contractors expressed concern that the current EPA-recommended protocols are contained in more than one document, which makes them difficult to understand completely. A single guidance document containing both procedures and protocols for proper AHERA clearance air monitoring could supplement existing EPA guidance (Guidelines for Conducting the AHERA TEM Clearance Test to Determine Completion of an Asbestos Abatement Project—EPA 560/5-89-001), which emphasizes interpretation of AHERA clearance results.

The inconsistent AHERA clearance sampling and analysis results obtained by monitoring firms and TEM laboratories should be investigated further in the context of the new training and National Voluntary Laboratory Accreditation Program (NVLAP) certification requirements to determine if additional corrective measures are needed. This problem is being addressed by EPA's Office of Toxic Substances; however, in the interim, compliance with the AHERA sampling and analytical methods should be strongly encouraged.

The persistent elevated asbestos concentrations found in perimeter and outdoor areas require further definition to determine the sources and to identify the appropriate corrective measures. Research proposed by RREL for FY '91 includes assessing methods of field-testing the high-efficiency particulate air (HEPA) filtration units. In the interim, the need for strict adherence to containment practices prescribed in the AHERA regulations should be emphasized.

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The complete report, entitled "AHERA Clearance at Twenty Abatement Sites," (Order No. PB91-217398AS; Cost: $17.00, subject to change) will be available only from:
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