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Project Summary

Observational Study of Final Cleaning and AHERA Clearance Sampling

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A study was conducted during the summer of 1988 to document final cleaning procedures and evaluate Asbestos Hazard Emergency Response Act (AHERA) clearance air-sampling practices used 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. Final cleaning practices tend to be similar among abatement contractors. Meticulous attention to detail in cleaning practices is important to a successful final cleaning. Sites passing a stringent, "no-dust" criterion of a thorough visual inspection are more likely to pass the AHERA TEM clearance test. AHERA sampling and analytical requirements and recommendations are not completely understood and followed by consultants conducting clearance air monitoring.

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 U.S. Environmental Protection Agency (EPA) has issued a final rule regarding inspections, abatement, and management of asbestos-containing materials in schools (October 30, 1987; 52 CFR 41826). The final rule specifies a clearance sampling protocol for determining when an asbestos-abatement site is clean enough for the critical containment barriers to be removed. It further specifies the phase-in of transmission electron microscopy (TEM) as the analytical method to be used on air samples taken for clearance monitoring.

The final cleaning phase of an abatement project is paramount to achieving a successful abatement as defined in the AHERA final rule. Final cleaning applies to the phase of the abatement project that occurs after all visible asbestos-containing material has been removed from the substrate; the substrate has been brushed and wet-wiped; a sealant has been applied to the substrate and to plastic sheeting covering the floors, walls, and fixed objects to "lock-down" any invisible fibrils that might remain; and all plastic sheeting (excluding the critical containment barriers) has been removed. The final cleaning phase of the abatement involves the detailed cleaning of surfaces in preparation for final visual inspection and AHERA clearance sampling.

The Risk Reduction Engineering Laboratory of the EPA conducted a study to document the final cleaning procedures and evaluate AHERA clearance sampling practices used at different asbestos-abatement projects. This report presents the observations made at 20 asbestos-abatement projects in New Jersey during the summer of 1988.

Procedures

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 (a) removal of sprayed- or troweled on surfacing material; (b) removal of thermal system insulation of mechanical equipment (i.e., boilers, tanks, heat exchangers, pipes, etc.); or (c) removal of suspended ceiling panels.
3. The abatement project was governed by written specifications that were to comply with the minimum requirements of the State of New Jersey, Asbestos Hazard Abatement Subcode (N.J.A.C. 5.23-8) and EPA guidance for work practices and procedures to be used in performing asbestos-abatement projects.
4. The abatement project was to be cleaned and cleared in accordance with the sampling protocol specified in the AHERA final rule (October 30, 1987; 52 CFR 41826).

A site documentation form provided the following information for each abatement project:

1. The abatement area's use (classroom, corridor, boiler room, etc.) and dimensions.
2. The type (acoustical plaster, ceiling panels, pipe insulation, etc.) and quantity (square feet or linear feet) of asbestos-containing material (ACM) abated, and type and percentage of asbestos in the ACM.
3. Final cleaning procedures and work practices.
4. Performance of negative-pressure air filtration systems including the static pressure differential across critical containment barriers and the airflow of each air filtration unit.
5. Results of final visual inspections conducted by the asbestos safety technician and/or inspector from the Asbestos Control Service (ACS) of the New Jersey Department of Health, including reasons why the visual inspection failed.

The background information describing the abatement area, the ACM abated, and other miscellaneous information was obtained by interviewing, at each site, an asbestos safety technician (AST) certified by the New Jersey Department of Community Affairs and employed by an Asbestos Safety Control Monitor (ASCM) firm. The ASCM firm is hired by the school district or Local Education Agency (LEA). The AST continuously monitors and inspects 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.

A site documentation form was also used to document the following AHERA clearance practices used at each site:

1. Conditions of sampling, i.e., aggressive versus nonaggressive sampling, use of fans to maintain air turbulence during clearance air sampling, etc.
2. Air sampling methods, i.e., filter medium, cassette type, flow rate, etc.
3. Performance of negative-pressure air filtration systems, including the static pressure differential across critical containment barriers and the airflow performance of each air filtration unit.

Airflow and Static Pressure Differential

The airflow performance of the air filtration units operating during both the final cleaning and AHERA clearance phases of the abatement was measured. The air velocity of the rectangular air-intake face of each air filtration unit was measured to estimate the airflow performance of the units. The air-intake face was divided into 16 equal rectangular areas, and the velocity was measured at the center of each area. The air velocity was measured with a calibrated, constant-temperature, thermal anemometer. The static pressure differential across the critical containment barriers was measured at each site during both the final cleaning and AHERA clearance phases of the abatement. The static pressure differential (inches of water) was measured with a calibrated, electronic, digital micromanometer.

Quality Assurance of AHERA Clearance Data

Clearance of each abatement site was based on the analyses of the final clearance air samples collected by the AST. The analyses were obtained from the laboratory report contained in the final project report prepared by the ASCM firm. The analysis of the samples and the corresponding quality control and quality assurance procedures were specified by the contract with the performing analytical laboratory to be conducted in accordance with the requirements i AHERA final rule. The conditions of pling and the sampling procedures by the AST were documented for parison with the requirements specifi the AHERA final rule.

Results and Discussion

Site Description

Sixteen of the 20 abatement pro involved general occupancy areas (c rooms, offices, recreational rooms, ridors, etc.); three involved boiler rc and mechanical equipment rooms; one involved both types of areas. ACM abated at 13 of the project involved surfacing material (sprayec troweled-on), 8 involved thermal sys insulation on mechanical equipn (pipes and boilers), 3 involved both facing material and thermal system i lation, and 2 involved suspended ce tiles. The ACM contained chrysc asbestos (from 2% to 93%) at projects, amosite asbestos (from 2% 10%) at 2 projects, and both chrys (from 10% to 75%) and amosite (f 30% to 40%) at 1 project.

Ventilation and Static Pressure Differentials

Air-intake volumes for each hi efficiency particulate air (HEPA) filtra unit in operation during final cleaning a AHERA clearance sampling were me ured at each of the 20 sites. Seven ferent models were observed and eva ated. The average operating airflow each model was compared with t manufacturer's nominal airflow, i.e., t manufacturer's advertised rated pe capacity. Actual average operating airfl ranged from 50% to 80% of the nomi airflow for seven models. The reduc airflow performance of the filtration un is probably due to the increased sta pressure associated with extended a obstructed exhaust duct conditions and increased particulate loadings on t filters. The significance of this reduc operating flow rate is in the procedu used to determine the number of a filtration units necessary to achieve t desired minimum ventilation rate (i.e four air changes per hour). Th assumption that the air-filtration units a operating at the manufacturer's specifie nominal airflow rate could result in actu ventilation rates significantly belo project design specifications.

Despite the lower-than-assumed ven tilation rates of the observed HEPA iltration units, enough units were used at all but one site to achieve a minimum of four air exchanges per hour during AHERA clearance sampling. Also, only two sites failed to meet the recommended air-exchange rate during final cleaning. Actual air-exchange rates ranged from 2 to 13/h during final cleaning and 3 to 13/h during AHERA clearance sampling.

Static pressure differential across the containment barriers was measured at one or more test locations at each of the 20 abatement sites during both final cleaning and AHERA clearance sampling. Eight of the 20 sites showed an average static pressure differential of at least -0.02 in. of water during final cleaning. Nine sites showed an average pressure differential of at least -0.02 in. of water during AHERA clearance sampling. The average static pressure differential for all sites ranged from -0.03 to -0.01 in. of water during both final cleaning and AHERA clearance sampling.

Continuous monitoring of the static pressure differential across the containment barriers was conducted at only one site. Ventilation smoke tubes were typically used at the beginning of each work shift at all abatement sites to verify visually that the containment enclosure remained under negative pressure (i.e., a noticeable inward movement of air existed through the decontamination facility).

Final Cleaning Work Procedures and Practices

In this study, final cleaning began at each project site after the encapsulated plastic sheeting was removed from the walls, floors, and fixed objects. The critical barriers, windows, doors, and heating, ventilation, and air-conditioning (HVAC) vents remained sealed. The air-filtration units remained in service.

Table 1 presents a matrix of the final cleaning procedures and work practices used at the 20 asbestos-abatement sites. At two abatement sites (Sites E and J), aggressive cleaning techniques were used. Aggressive cleaning involves sweeping the surfaces with the exhaust from a hand-held 1-horsepower leaf blower to dislodge any residual debris, and then allowing the airborne particulate to settle. Aggressive cleaning was conducted at Site E after the site had failed the first AHERA clearance attempt and before it was recleaned; and at Site J after the walls and other surfaces had been sprayed with water and allowed to dry and after hard-to-reach areas such as indented corners, crevices around doors and windows, etc., had been cleaned with a vacuum equipped with a HEPA filter.

The sequence and nature of the cleaning tasks seemed to depend on the substrate from which the ACM was removed (e.g., concrete ceiling versus a T-bar grid system for suspended ceiling tiles) or on the structural makeup (i.e., concrete walls, wood floor in a gymnasium, etc.) of the abatement area. Final cleaning usually began by spraying the walls, plastic critical containment barriers, and other surfaces with a water mist to remove any loosely bound debris. The resultant asbestos-containing water on the floor was gathered into pools by use of a rubber squeegee or (less frequently) with push-type brooms. The bulk of the pooled water was scooped up with plastic-bladed shovels. The water was placed in double-layered, 6-mil-thick, asbestos-disposal bags, which generally contained plastic that had been removed from the walls and floors or protective clothing that had been used by the workers. The residual water removed with a wet vacuum was also placed in the disposal bags. At one site, a commercially available gelling agent was also added to the disposal bag to gel the water to minimize the potential for its subsequent release during storage.

At two sites, some of the wash water penetrated the seams between the floor tiles and caused them to buckle. These buckled floor tiles were sporadically distributed throughout the abatement areas. At both sites, the asbestos-containing water beneath the floor tiles was allowed to dry, and the tiles were not repaired as part of the abatement. These areas could be potential sources of airborne asbestos fibers when repaired later by maintenance personnel.

Although to a lesser extent than the spraying of surfaces with water, some final cleaning began with the scraping or brushing of the substrate to remove any visible debris.

The surfaces, particularly hard-to-reach areas such as indented corners, crevices around doors and windows, floor-wall junctures, etc., were then cleaned with a HEPA-filtered vacuum. At several sites, final cleaning began with the HEPA-vacuuming of surfaces.

The vertical and horizontal surfaces were then wet-wiped with amended water. The contractors reportedly prepared the amended water solution by mixing approximately 1 or 2 oz. each of 50% polyoxyethlyene ester and 50% polyoxyethylene ether in 5 gal of water.

The elevated horizontal and vertical surfaces were usually wiped first, and then all the other surfaces. All the surfaces except the floors were wiped with cotton rags, paper towels (bath size), or a sponge dampened with amended water. Several abatement contractors said they did not use cotton rags or sponges because their repeated use increased the potential for smearing residual particulate on the surfaces being cleaned. Although the paper towels were sometimes reused, such reuse appeared to be markedly less than that observed for cotton rags or sponges at other sites. Deterioration appeared to be the primary factor that prompted a worker to discard a paper towel. A bucket of amended water was either used by a single worker or shared by several workers and the same bucket was used for both rinsing and dampening of the rags or paper towels. The workers did not wipe the surfaces in any one direction. The cotton rags, paper towels, or sponges were not replaced frequently, especially during the cleaning of elevated and hard-to-access surfaces. Nor was the amended water changed frequently.

After the walls, windows, and other surfaces had been wet-wiped, the last step in the final cleaning involved a complete mopping of the floors with a clean mop head wetted with amended water. The floors were mopped once at 7 of the sites and twice at 13 of the sites. The mop heads were changed infrequently. No changes in the water were observed during this procedure at any of the sites.

Before the floors were mopped a second time at four of the sites, the plastic sheeting covering the air-filtration units and a plastic sleeve that covered the associated flexible exhaust ducts were removed. Both coverings had been installed before abatement work began. According to the contractors, this practice simplified the cleaning of this equipment, particularly the flexible exhaust ducts.

At all sites, wastewater from the wet-wiping and mopping operations was treated as asbestos-containing water and placed in double-layered, 6-mil-thick, standard asbestos disposal bags. These standard asbestos disposal bags which contained wastewater were not placed in leak-tight containers. The wastewater in the disposal bags was solidified with a gelling compound at one of the 20 abatement sites. The rags, paper towels, sponges, mop heads, and other materials used during final cleaning were also placed in these bags. The bags were not

Table 1. *Matrix of Final Cleaning Work Practices and Procedures*

Final Cleaning Practices and Procedures	Abatement Site and Sequence of Final Cleaning[a]																				
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	Total
Worked toward decontamination facility	X	X			X	X			X	X	X	X	X	X	X	X	X	X	X	X	16
Worked away from decontamination facility			X	X			X	X													4
Aggressive cleaning "air sweeping" surfaces					X					X											2
Spraying of surfaces with amended water															2						1
Spraying of surfaces with water	1			1		1	3	1		1				2	2	1	3			1	11
Wire-brushing of abated surfaces			1				1						1	1							4
Scraping, brushing ceiling-wall intersections		1							1			1					1		1		5
HEPA-vacuuming of corners, crevices, floorwall intersections	2	2	2	2			2	2	2	2	1	2	2	3	1		2	2	2		16
Wet-wiping of horizontal and vertical surfaces																					
• Cotton rags dampened with amended water	3	3		3			4			3	2			4	3	3	4	3	3	2	13
• Paper bath towels dampened with amended water			3		1	2		3				3	3								6
• Sponge dampened with amended water									3												1
Dry sweeping of floors									3												1
Wet mopping of floors with amended water	4	4	4	4	2	3	5	4	4	4	3	4	4	5	4	4	5	4	4	3	20
Removing plastic sheeting from air-filtration units and associated exhaust dusts	5														5			5	5		4
Wet mopping of floors with amended water a second time	6	5		5	3		6	5	5	5		5	5	6	6			6			13
Wet-wiping and/or HEPA-vacuuming of designated areas based on AST's visual inspection	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	18
Wastewater and disposable cleaning materials placed in double-layer 6-mil-thick plastic bags	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	20
Wet-wiped asbestos-disposal bags before removing from abatement area																					0
Miscellaneous observations																					
• Cleaning water beneath vinyl floor tiles	X															X					2
• Use of agent to gel wastewater												X									1

[a]Number denotes sequence of final cleaning

wet-wiped with amended water before being removed from the abatement area.

Final Visual Inspection

Final visual inspection involves examining the abatement area for evidence that the remedial actions have been successfully completed, as indicated by the absence of residue, dust, and debris. The basic premise of a final visual inspection is that an area where residue or debris visible to the unaided eye is still present is not clean enough for clearance air sampling.

Final Visual Inspection by AST's

Upon completion of final cleaning, a final visual inspection was conducted at each of the 20 abatement sites by an onsite AST. Two of the 20 sites passed the first visual inspection, and 18 of the 20 sites required and passed a second visual inspection.

Final Visual Inspection by NJDOH's ACS

The New Jersey Department of Health's Asbestos Control Service (ACS) conducted final visual inspections at 15 of the 20 abatement projects. These included Sites A through C, H through I and K through T. This inspection is a part of the State's traditional quality assurance program that provides checks and balances to asbestos abatement to ensure that high quality abatement and state-of-the-art work practices are used.

The ACS inspector first visually examined all substrate surfaces to ensure that no ACM remained. Special attention was given to pipes, structural members, ceiling tile grid bars, and irregular surfaces with corners and hard-to-reach areas. If any quantity of ACM remained, the site failed the visual inspection and additional removal work was performed before another visual inspection was conducted.

The ACS inspector then determined if the work site had been adequately cleaned. All surfaces were examined for dust and debris, especially overhead areas (such as tops of suspended light fixtures and ventilation ducts) and areas under stationary fixtures. One or both of the following techniques were used for examining surfaces to establish that a "no dust" criterion had been achieved:

1. Using a damp cloth to collect dust from the surface and then inspecting the cloth for evidence of dust.
2. Darkening the room and shining a flashlight so that the light beam just glances across any smooth horizontal or vertical surface. A gloved finger is then run across the illuminated area; if a line is left on the surface, dust is still present.

If either of these techniques showed that dust still remained, the ACS inspector recommended recleaning of the work area before its reinspection. If debris was found, the ACS inspector collected bulk or wipe samples of the debris and submitted them for analysis by the New Jersey Department of Health's Public Health and Environmental Laboratories in Trenton, New Jersey.

From one to seven visual inspections were conducted at each of the 15 abatement sites inspected by the ACS. The largest percentage of sites (33.5%) passed the visual inspection on the second attempt. The cumulative percentages of sites passing the visual inspection were as follows: 40% by the first and second attempts, 66.7% by the third attempt, and 93.4% by the fourth attempt.

Fourteen of the 15 sites failed the ACS inspectors' visual inspection for more than one reason. The most commonly identified reason (cited at 8 of the 15 sites) was the presence of debris on pipes, pipe fittings, and hangers. The next most common reason was debris on floors, on horizontal surfaces, and in wall-penetrations. Twenty-three other less commonly reported reasons for failing the visual inspection were also identified.

The ACS inspectors collected 81 bulk samples to determine the asbestos content of the debris found during the visual inspections. Asbestos was present in approximately 90% (73 of 81) of these samples.

All 20 abatement sites passed an onsite AST visual inspection according to each AST requirement. Fifteen of the 20 sites were subsequently inspected by the NJDOH's ACS inspectors. Only one site passed the first ACS visual inspection. Observation of inspection practices and procedures showed that the ACS inspectors conducted a more stringent and thorough visual inspection.

Aggressive Sampling

Air monitoring for postabatement clearance should be conducted under aggressive sampling conditions. The abatement area floors, walls, ledges, ceilings, 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 sweeping of the abatement area for a minimum of 5 min/1000 ft^2 of floor area. The AHERA rule recommends the use of at least one stationary fan per 10,000 ft^3 of workspace to keep the asbestos fibers suspended during sampling.

Nineteen of the 20 observed abatement sites used aggressive sampling techniques. Fourteen of these 19 sites failed to meet the recommended aggressive air-sweeping rate of at least 5 min/1000 ft^2 of floor area.

Only 12 of the 20 sites used stationary air fans to maintain a constant air movement during clearance air sampling. Box-type fans were used at nine of these sites, and pedestal-type fans were used at three sites. Fifteen of the observed sites failed to use the number of fans per given volume of workspace recommended by AHERA.

Filter Types

Mixed cellulose ester membrane filters were used in the collection of clearance air samples at 14 of the 20 observed abatement sites. Polycarbonate membrane filters were used at six sites. Although the AHERA rule permits the use of either filter type, the pore size must be less than or equal to 0.45 µm 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, which 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.

Filter 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 after a set length of time so a certain minimum air volume could be achieved. The AHERA rule states that pump flow rates between 1 and 10 L/min may be used for 25-mm-diameter filters. This was practiced at 18 of the 20 sites observed. Only at two sites were air samples collected at flow rates greater than 10 L/min. Air volumes ranged from 1320 to 4161 L for the post-abatement air samples collected inside and outside the abatement area at the observed sites. The AHERA rule recommends sampling between 1200 and 1800 L of air for 25-mm-diameter filters.

Clearance Tests

At 18 of the 20 observed sites, the laboratory reports indicated that final clearance air samples were analyzed by TEM in accordance with either the mandatory or nonmandatory TEM methods described in AHERA. At two sites, phase contrast microscopy was used to analyze the clearance air samples. Although the samples were reportedly analyzed in accordance with NIOSH Method 7400 at these two sites, the clearance samples were collected using improper filters, i.e., collected using 0.4-µm-pore-size mixed-cellulose ester filters instead of 0.8-µm-pore-size mixed-cellulose ester filters specified in the NIOSH Method.

Eighteen of the 20 sites were cleared by the AHERA TEM tests. One to three TEM clearance attempts were made per abatement site. Approximately 83.3% of the sites passed on the first attempt after passing a thorough visual inspection.

All of the 18 sites ultimately passed the AHERA TEM clearance criterion of the initial prescreening test (i.e., the average asbestos concentration of the samples collected inside the abatement area was less than or equal to 70 structures/mm^2). Three of the 18 sites initially failed the prescreening test, and 2 of these sites subsequently tried to use the Z-Test to pass clearance. In each case, the site also failed the Z-Test and had to be recleaned. The Z-Test was used only twice at the 20 sites observed in this study, and it was never used to clear the abatement site.

Three of the 20 sites were inspected by only the AST and subsequently cleared by TEM. Two of these three sites failed the first TEM clearance attempt after passing the AST visual inspection. One site required additional cleaning and passed TEM clearance on the second attempt. One site required three TEM clearance attempts after additional visual inspections by the AST before it was cleared. Polycarbonate filters were used to collect air samples at this site. Background asbestos contamination in the field blanks showed an average asbestos concentration of 53 structures/mm^2 on the first clearance attempt and 105 structures/mm^2 in the second attempt. The field blanks were not analyzed on the third clearance attempt. Of the 15 sites that passed the NJDOH visual inspection, 14 subsequently passed TEM clearance on the first attempt.

After having passed a thorough visual inspection by the ACS, the largest percentage (83.3%) of the sites passing the ACS visual inspection passed the AHERA TEM clearance on the first attempt. Only 6.7% (one site) failed the AHERA TEM clearance after passing a thorough visual inspection. These data support the premise that effective final cleaning practices that meet the standards of a thorough visual inspection strongly influence whether the AHERA clearance test or other TEM clearance tests will be passed.

One site involved the removing of less than 3000 ft^2 of ACM. For smaller projects such as this, AHERA permits the use of phase contrast microscopy to analyze the clearance samples. Five samples must be collected inside the abatement area and each must have a fiber concentration of less than or equal to 0.01 fiber/cm^3 of air to pass the clearance criterion. Only one sample was collected at this site, and its fiber concentration was less than 0.01 fiber/cm^3. Site clearance was based on this one air sample, which is not in accordance with the five samples required by AHERA.

One other site was cleared by phase contrast microscopy analysis. According to AHERA regulations, however, clearance of this site required the use of the TEM clearance criterion. At this site, only two samples were collected inside the abatement area, and the fiber concentration associated with each was less than 0.01 fiber/cm^3. Site clearance was based on these two samples, whereas the PCM AHERA clearance criteria require a minimum of five samples inside the abatement area.

Conclusions

The following are the principal conclusions reached during this study:

1. Final cleaning practices tend to be similar among abatement contractors. The sequence of cleaning activities depends on the surface from which the asbestos was removed and the physical structure of the work site. Meticulous attention to detail in cleaning practices is important to a successful final cleaning.
2. HEPA-filtration units used under normal operating conditions at asbestos abatement sites tend to perform below the manufacturer's nominal airflow. The average operating airflow ranged from 50% to 80% of the rated nominal airflow for 93 units representing 7 model types.
3. Sites passing a stringent, "no-dust" criterion of a thorough visual inspection are more likely to pass the AHERA TEM clearance test. Thirty-three percent of the sites that passed only the Asbestos Safety Techni (AST) visual inspection, and were subsequently inspected by the I Jersey Department of Health, pas AHERA TEM clearance on the attempt. Ninety-three percent of sites that passed a more thoro visual inspection by the NJD passed AHERA TEM clearance the first attempt.
4. The initial AHERA Clearance Scre ing Test, requiring an average asb tos concentration below 70 str tures/mm^2, is achievable in m cases, thereby eliminating the n to employ the AHERA Z-test. All sites cleared by TEM passed the p screening AHERA TEM clearar criterion of 70 structures/mm^2.
5. AHERA sampling and analytical quirements and recommendations not completely understood and f lowed by consultants conducti clearance air monitoring. The follc ing clearance air sampling and ar lytical techniques were observed:
   - Fewer than the required fi clearance air samples inside t abatement area were collected two sites.
   - Improper sampling media we used to collect clearance samples, i.e., filter pore size three sites and filter type at t sites cleared by PCM.
   - Eight of the 20 abatement sit failed to meet the EPA-recor mended drying time of 24 hou after final cleaning was complete before final clearance air monitc ing was conducted.
   - Recommended air sampling flc rates were exceeded at two sites
   - Phase contrast microscopy wa improperly used to clear one site
   - Nineteen of the 20 abatemer sites used aggressive air san pling techniques. Fourteen these 19 sites failed to meet th EPA-recommended aggressive a sweeping rate of at least min/1000 ft^2 of floor area.
   - Fifteen of the 20 abatement site failed to use the number of circu lating fans recommended b AHERA during final clearance a monitoring. No circulating fan were used at eight of the sites.

Recommendations

Based on the conclusions outline above, it is recommended that guidanc documents be developed which addres the following topics:

1. *Procedures for visual inspections.* This study suggests that work sites passing a stringent visual inspection are less likely to fail the clearance test and incur the expense of multiple rounds of sampling and analysis. Guidance for performing a thorough visual inspection would benefit both the building owner and abatement contractor.
2. *Procedures and protocols of AHERA air monitoring.* Improper final clearance air monitoring resulted partly from a lack of understanding of AHERA air monitoring procedures. The contractors expressed concern that the EPA-recommended protocols were in different documents, making it difficult to completely understand the current protocols. The AST recommended that a guidance document be prepared that contained the procedures and protocols for proper AHERA clearance air monitoring.
3. *Operation of HEPA filtration units.* No specific guidance has been issued regarding the fundamental operating principles of these units (e.g., decreased airflow performance with increased static pressure due to filter loading and the addition of manifolds, flexible ductwork, etc.). Guidance for maximizing the operating airflow performance of air-filtration units used at asbestos abatement sites is needed.

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The complete report, entitled "Observational Study of Final Cleaning and AHERA Clearance Sampling," (Order No. PB 89-233 449/AS; Cost: $28.95, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
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The EPA Project Officer can be contacted at:
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