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PROJECT REPORT

THE SAFE ASBESTOS TREATMENT PROGRAM
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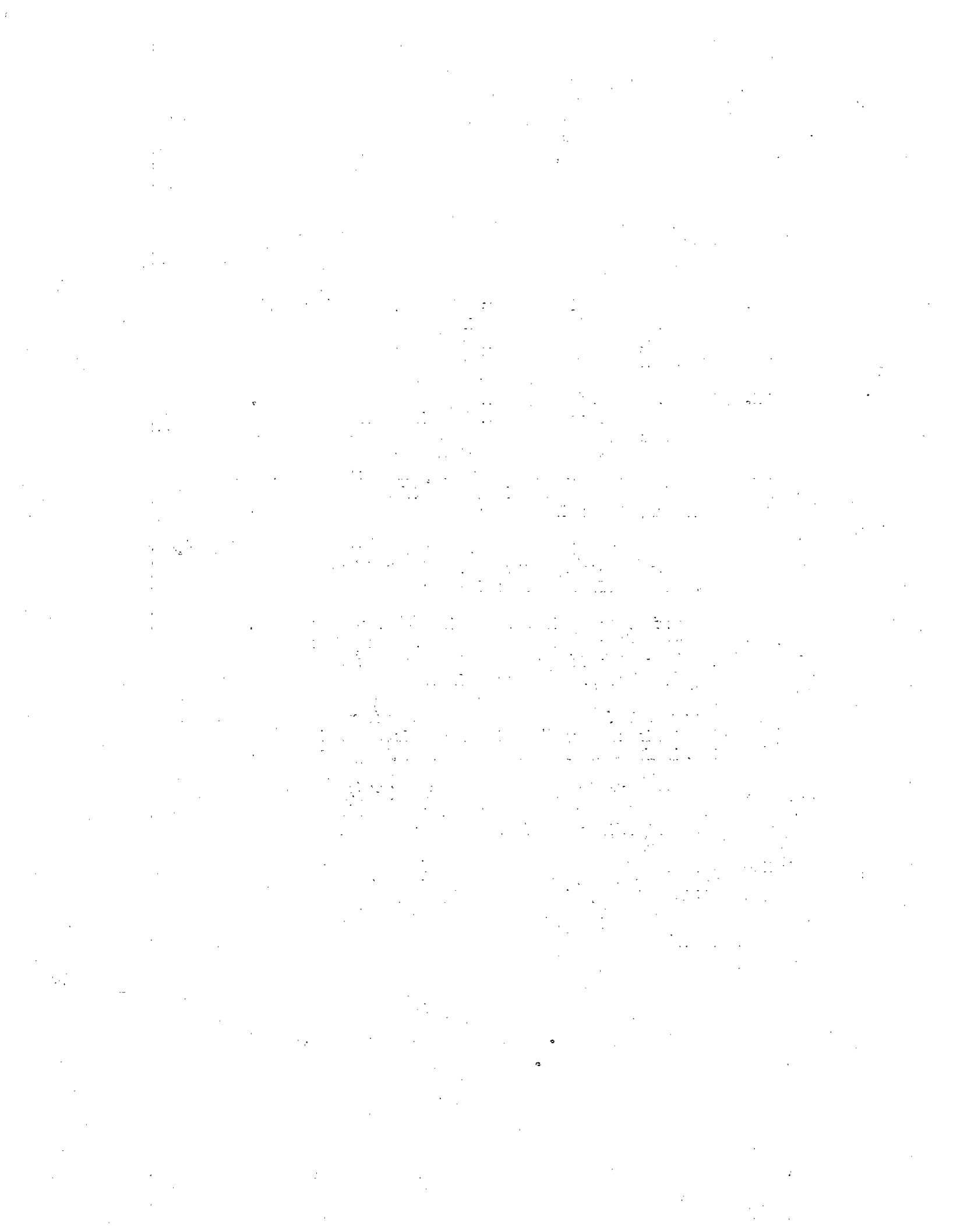
George Yamata, Director, Particulate Analysis, IIT Research
Institute, Chicago

The "real" work of Program staff occurred at the school district level within several school buildings throughout the state of Colorado. It was appreciated by Program staff when planning the activities of the Safe Asbestos Treatment Program, that school district personnel are the frequent recipients of requests to conduct studies within their districts. Consequently, Program staff express special commendation to those superintendents, building principals, and other district staff for their cooperation and assistance in the "field" work associated with the Safe Asbestos Treatment Program, and specifically for the expression of interest and concern this demonstrated for the continued good health and well-being of the children they serve..



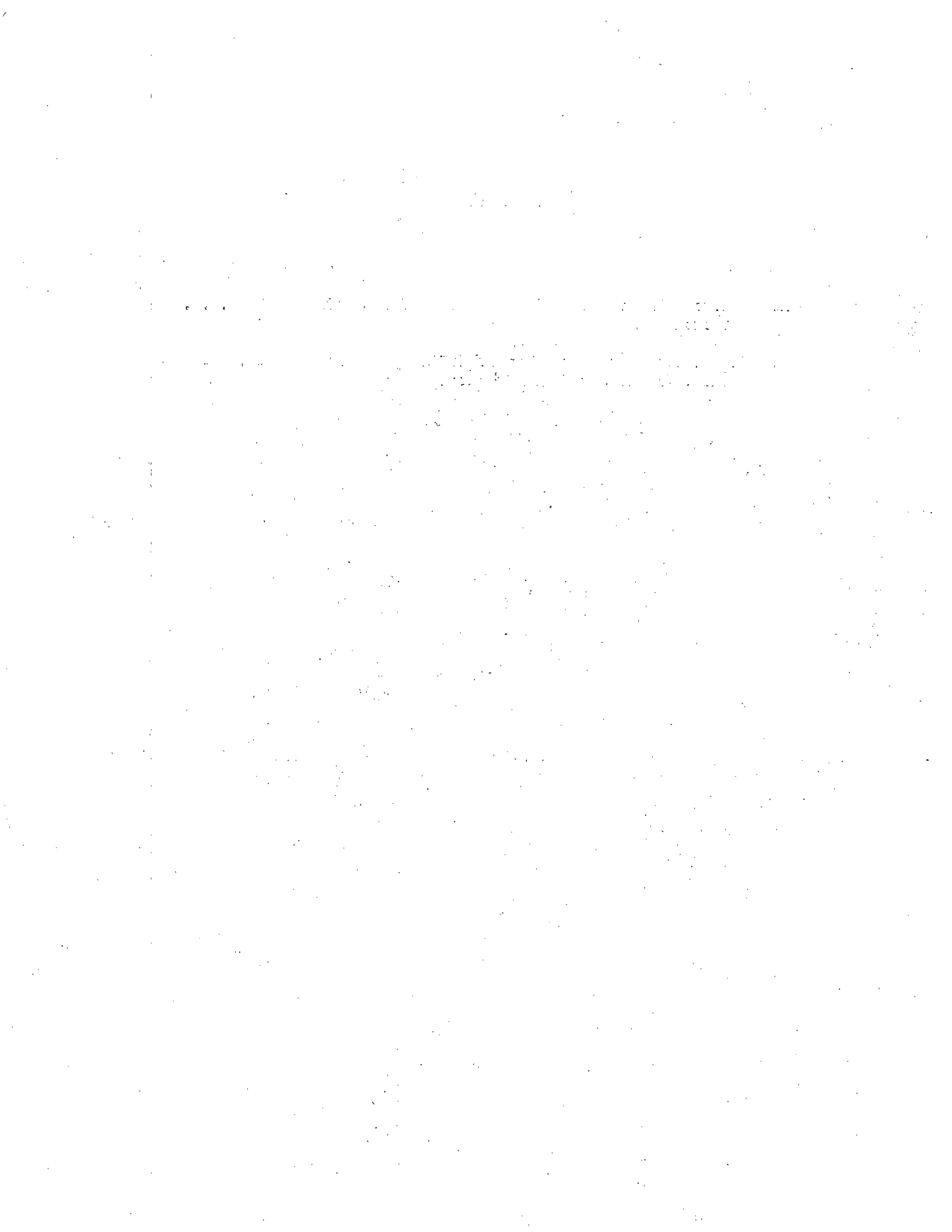
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ABSTRACT

The primary purpose of the Safe Asbestos Treatment Program (SAT) was to conduct research into the prevalence and condition of asbestos-containing materials in Colorado public schools and to document the levels of airborne asbestos in several Colorado public school facilities which contained sprayed-on asbestos material.

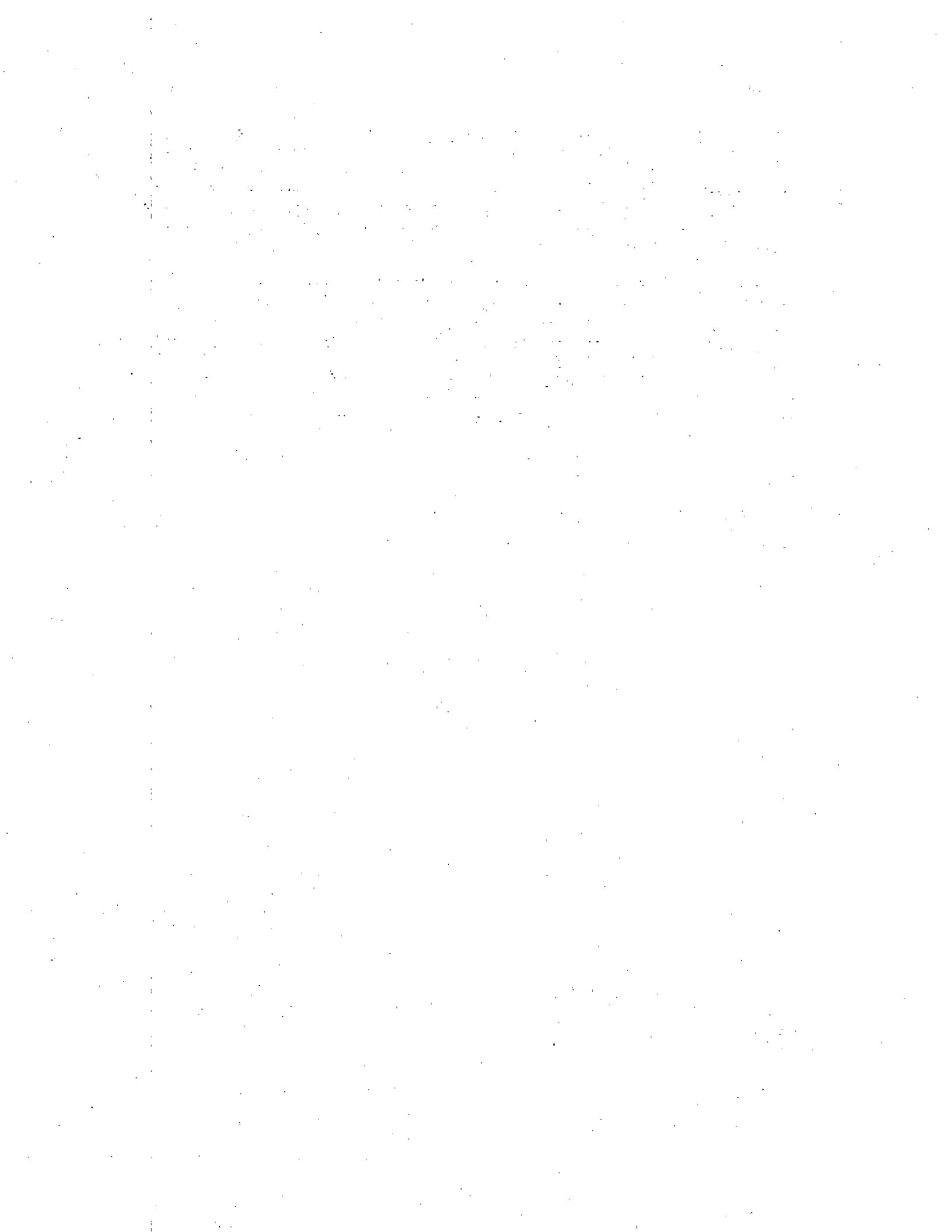
One hundred and thirteen bulk samples were collected from a random sample population of schools which represented 3.2% of Colorado's public schools. The K^2 Asbestos Screening Test gave a negative result for iron and magnesium on 12 of the bulk samples collected. Confirmational analysis on those samples positive by the K^2 Test was by polarized light microscopy. This technique confirmed that asbestos was present in 56 of the samples positive by the K^2 Test. At the 95% confidence level, it was estimated that between 63% to 89% of Colorado's public schools may contain some type of asbestos materials and that between 10% to 38% may contain sprayed-on asbestos materials. The K^2 Test was not recommended for use by school officials because of the high number of false positives and the use of strong acids as reagents.

Air samples were taken inside and outside of six Colorado school facilities with sprayed-on asbestos materials. All samples were analyzed by phase contrast microscopy and selected samples were analyzed by scanning electron microscopy (SEM) and transmission electron microscopy coupled to selected area electron diffraction and energy dispersive X-ray analysis (TEM-SAED-EDXA). The levels of airborne asbestos found for the buildings depended on the analysis technique. Results from phase contrast yielded concentrations in the thousandths of a fiber per cubic centimeter of air (f/cc) or less. Concentrations determined from SEM were in the hundredths of a f/cc or less. TEM-SAED-EDXA gave concentrations in the tenths of an asbestos f/cc. When the outside concentrations were subtracted from the respective average concentrations within the buildings, two schools showed airborne asbestos levels in the tenths of an asbestos f/cc. TEM-SAED-EDXA was felt to be the best analytical approach for environmental asbestos air samples because small fibers were counted and asbestos fibers were specifically identified.

Prior to conducting the research, a pilot study was carried out in 29 Colorado schools. Through this experience the procedures, methods, and materials used with the "study sample" were developed and refined. SAT Program staff also provided educational sessions and talks on asbestos for 290 participants primarily from the construction industry and school maintenance departments; however, school district officials were also present at these sessions. Two pamphlets and seven newsletters were written by SAT Program staff. To date, these materials have been distributed to approximately 15,000 individuals both in Colorado and throughout the United States.

Additionally, SAT Program staff participated in several media events. The SAT Program and staff efforts were broadcasted via local TV (three Denver stations) and numerous radio stations. Stories were also printed in Denver's two leading newspapers, and articles appeared in virtually every newspaper in the State. It is difficult to evaluate the specific outcomes of media coverage; however, at a minimum this type of coverage served as an "awareness building" tool.

An extremely positive outcome of the activities carried out by SAT Program staff was the degree of interest generated among the construction industry. Due to SAT Program activities, Colorado now has several contractors who are prepared to conduct asbestos treatment or removal work. This was no menial task, in that years of myth needed to be scrubbed away and new skills taught. During the study period, SAT Program staff responded to 28 requests from contractors involved in asbestos treatment or removal projects. Presently, these types of requests are received on a regular basis.



INTRODUCTION

The presence of asbestos-containing materials in school buildings has generated a special concern. A population of active students increases the potential for damage to material, and since students spend a large portion of time in school buildings, exposures could be of potentially long duration. Contamination of the indoor air in school buildings would affect a large number of people including not only students but instructors, custodians and other support staff. A major concern is that children would be exposed early in life leaving many years for the development of an asbestos induced cancer.

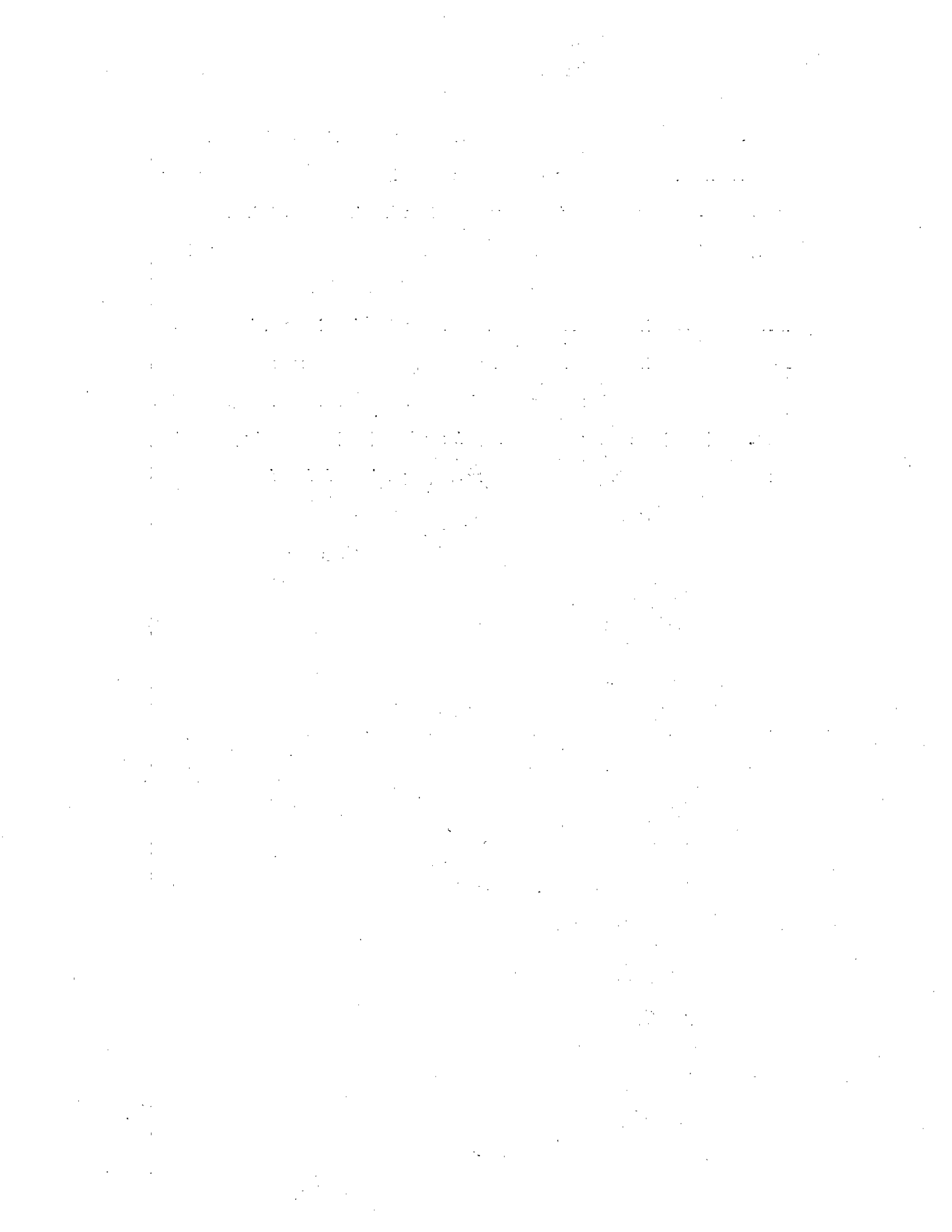
The primary purpose of the Safe Asbestos Treatment Program (SAT) was to conduct research into two areas: (1) the prevalence and condition of asbestos-containing material in Colorado public school buildings, and (2) the levels of airborne asbestos in selected Colorado public school facilities with sprayed-on asbestos material.

A stratified random sample of schools was selected and facilities were evaluated for the presence of asbestos in building materials. An assessment of material condition and its potential for fiber release was made for each building material identified as containing asbestos. Air samples were taken in selected schools with sprayed-on asbestos materials and analyzed by three different techniques to determine air concentrations of asbestos. Secondary information was gained concerning analysis techniques used to fulfill the two research directives.

As well as directly identifying the asbestos problems in some schools, the program benefitted the school system and general community



in other ways. It provided a structure for education of school personnel, and contractors on asbestos health hazards and proper work practices. Program services were made available to schools not included in the random sample population. Awareness of the problems associated with asbestos materials was heightened in the community. This was accomplished through talks to professional organizations, newspaper articles, TV news coverage, and outreach programs initiated by SAT Program staff and staff of the Occupational Health and Safety Section (OHSS) at Colorado State University (CSU). Staff responsible for the Safe Asbestos Treatment Program are identified in Appendix A.



BASIC PROGRAM APPROACH

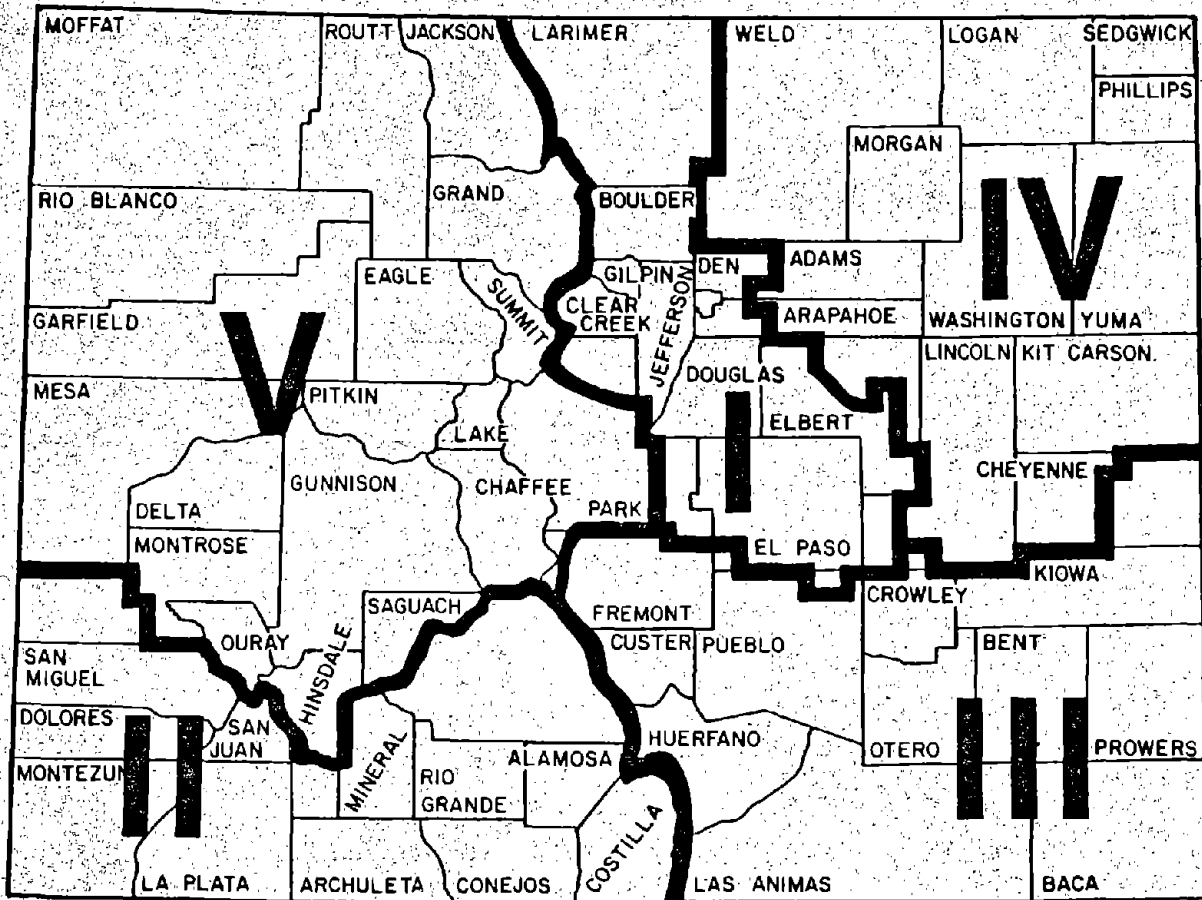
To initiate the Program, objectives and methods were presented to area Environmental Protection Agency (EPA) personnel and state level education administrators. This accomplished three tasks: it provided introductions to those whose support and cooperation was necessary to the project; it facilitated the dissemination of information to district level superintendents and school personnel; and allowed for the orderly collection of descriptive material on Colorado public school buildings. Information obtained from EPA officials (acquired from their voluntary mail survey on asbestos material in Colorado schools), along with Colorado State Department of Education information, was used to select a stratified random sample of Colorado public schools for research purposes.

Selection of Random Sample

A random sample of Colorado public schools was chosen with schools clustered by school districts and stratified based upon the population of schools within each of five State Department of Education regions (see Figure 1). School districts and schools were assigned a number, and these numbers were entered into a computer which performed the randomized selection procedure.

The total number of schools included in the study from each region was directly proportional to the number of schools in the region. To cluster the sample population, all schools were chosen from one school district for each of Regions II through V. For Region I three





COLORADO DEPARTMENT OF EDUCATION REGIONS,
FALL AND WINTER 1980

FIGURE 1



school districts were used, and the number of schools selected from each district was proportional to the number of schools within that district.

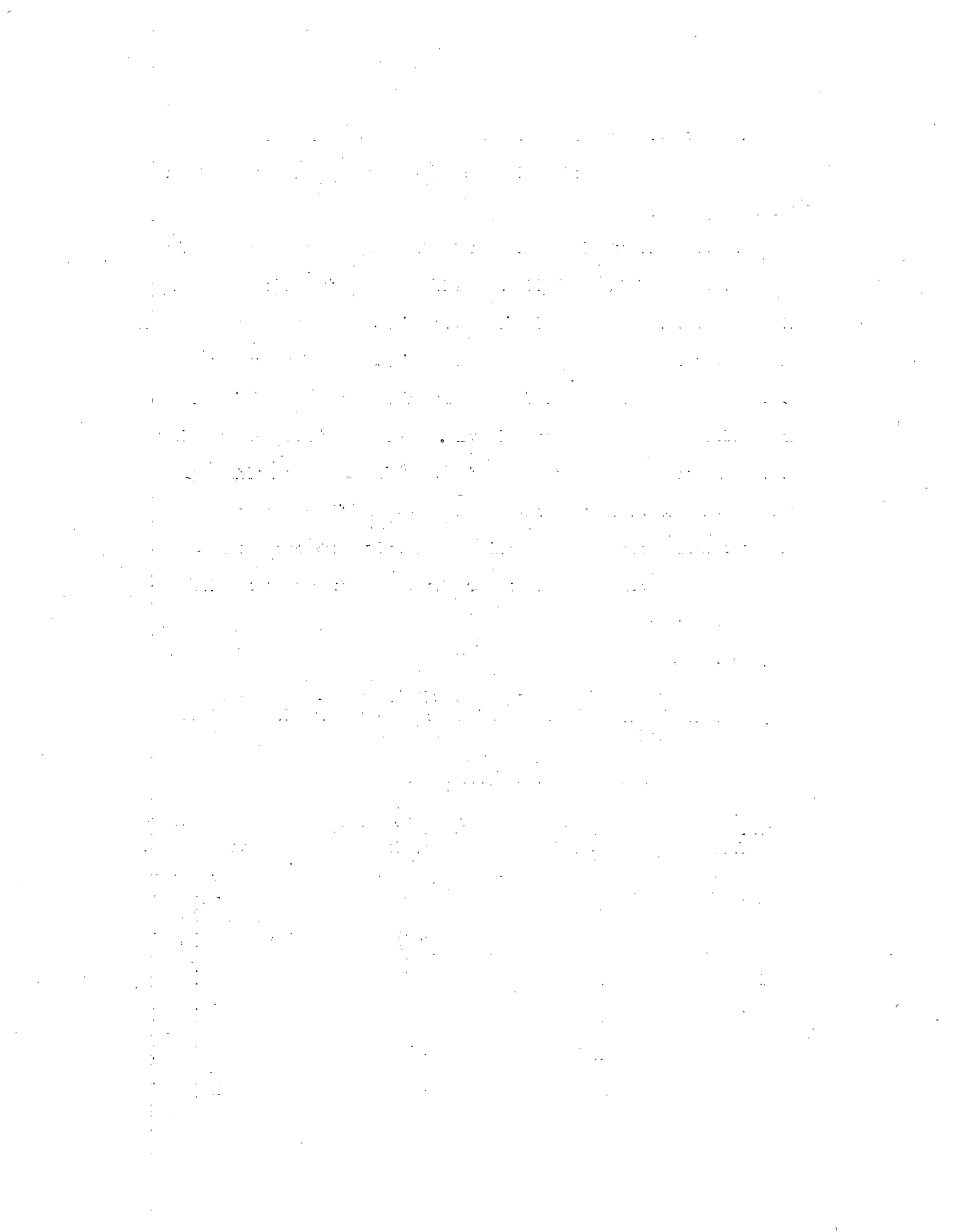
In this manner, 41 schools across the state were chosen. This represented about 3.2% of all the public schools in Colorado. Table I shows the number of schools in each region, and the number of school districts and schools sampled in each region. Schools were further categorized by date of building construction, date of addition and remodelling jobs, and by grade levels. Tables depicting the results of this categorization are presented in Appendix B. The result of the randomized selection procedure was that each region was represented proportionally in the sample, all grade levels were represented, and a broad spectrum of building construction dates and remodelling job dates were represented.

TABLE I

TABLE I

Number of Schools, Number of School Districts, and Number of Schools Sampled by State Designated Region for Colorado, Fall and Winter 1980.

State Designated Region	Number of Schools	Number of School Districts Sampled	Number of Schools Sampled
I	714	3	23 (3.2%)
II	94	1	3 (3.2%)
III	157	1	6 (3.8%)
IV	142	1	4 (2.8%)
V	156	1	5 (3.2%)
TOTAL	1,263		41 (3.2%)



Interactions

Interactions with the school personnel and others fell into three main categories: education, service, and research. For school personnel participating in the study a slide show and talk followed by a question and answer period on asbestos was conducted. This was followed by a building walk-through in which bulk samples were taken, material condition was assessed and an exposure potential calculated. For selected schools air sampling procedures were undertaken. Appropriate control measures were selected by school officials and SAT Program staff. Information was provided to the schools on materials and equipment necessary to implement the controls.

For school personnel outside of the study and for other groups interactions varied and depended on their needs and requests.

Educational Activities

Educational aspects of the SAT Program were not only directed to school officials and personnel but also to contractors, other health and safety professionals, and the general community. Educational activities conducted are outlined below.

Seminars for School Officials. District officials designated members from their facilities, maintenance, and administrative departments to attend the slide show and talk. In some school districts members of the local health department and local media were invited to attend by school administrators. The talk was followed by a question and answer period. The majority of questions related to proper work practices, disposal, and diseases of asbestos. SAT Program staff were able to assist in these areas by directly addressing the question or referring the party to the proper authorities. Further, talks were



also given to meetings of educational associations. Topics covered in the slide shows and talks are presented in Appendix C. One hundred and fifty-four people attended these sessions. A breakdown by activity is in Appendix D.

Information Folders and Pamphlets. An information folder was created and given to district officials of sample population schools. The folder contained four pamphlets from federal government agencies (listed in Appendix E) and two written by SAT Program staff (see Appendix F). The SAT Program pamphlet entitled "Asbestos: The Problem" covers the history, uses, diseases, etc., of asbestos. The second pamphlet, "Asbestos: Control of Asbestos Hazards - Actions, Steps and Resources" includes such items as a step-by-step inspection and assessment procedure, laboratories for bulk sample analysis, and manufacturers and distributors of protective clothing, asbestos vacuums, and wetting agents.

Fifty of the information folders and 500 additional copies of the SAT Program pamphlets were distributed to district officials, school maintenance personnel, members of the building trades, media people, and other interested parties.

Workshops and Seminars for Construction Industry Personnel. Information sessions were also given for members of the construction industry and for professionals in the health and safety fields. These sessions were presented for 129 participants (see "Non-School Organizations, Appendix D).

Telephone Tape. A link to the Colorado Cooperative Extension Service was established through their "Teletips" telephone information service. A script on "The Facts About Asbestos" was written by SAT Program staff for inclusion in the Extension's bank of taped information.



Emphasis was placed on what materials might contain asbestos, how and where to verify, and how to handle the materials.

Newsletters. SAT Program staff produced seven newsletters referencing asbestos and safe asbestos treatment procedures. These newsletters were distributed via the Construction Health Hazards Education Program (a program also carried out within the Occupational Health and Safety Section at Colorado State University). The newsletter is titled "Action Tips" and is distributed monthly to some 2000 individuals (see Appendix G for copies of these newsletters).

News Releases. The staff of Colorado State University's Communications Center distributed news releases concerning the Safe Asbestos Treatment Program to major Colorado newspapers and TV stations, and the story was picked up by smaller newspapers and radio stations throughout the state. SAT Program staff provided information to media people upon request concerning asbestos hazards, uses, control measures, etc., but information specific to a Colorado school or school district was not furnished.

Several newspaper articles, radio news spots, and TV news interviews resulted from this process. Example media releases are presented in Appendix H. Total numbers of persons impacted by state wide or local media may have approach the millions.

Service Activities

Program staff provided services to many groups in the community as well as to school groups.

School Building Surveys. A total of 70 schools were surveyed including the 41 selected in the random sample. Bulk samples were analyzed by a screening test by Program staff at CSU facilities. Samples



positive by the K² screening test were mailed to a laboratory for confirmational analysis by polarized light microscopy. By this process 177 samples were analyzed by the K² screening test, and 165 samples were further analyzed by polarized light. These analyses were performed without charge to the school districts.

Training of School Personnel to Perform Surveys. Some of the school districts trained people to do the building surveys by utilizing SAT Program services. By attending educational sessions, accompanying Program staff during building surveys, and by studying the SAT Program pamphlet "Asbestos: Control of Asbestos Hazards - Actions, Steps and Resources" designated facilities' people were trained to collect bulk samples and perform assessments in schools not surveyed by SAT Program staff members.

Control Measures and Implementation. Program staff assisted school personnel with the selection of control measures and necessary materials and equipment. Information on materials was included in the SAT Program pamphlet "Asbestos: Control of Asbestos Hazards - Actions, Steps, and Resources". Additional information was provided upon request.

Assistance to Contractors and Others. SAT Program staff were available for technical assistance to contractors and others involved with asbestos projects. Twenty-eight technical assistance requests were addressed for general information, 15 on asbestos removal, 13 for asbestos sampling and analysis, and one concerning substitutes for asbestos.

Research Activities

(A detailed overview of research conducted by SAT Program staff is presented in the next two sections of this report - "Description of Research Procedure" and "Research Results and Discussion.")

DESCRIPTION OF RESEARCH PROCEDURES

The protocol for carrying out this research included:

1. A pilot study to determine sampling and educational strategies;
2. The selection of the study sample;
3. Developing and delivering educational sessions and materials to school officials within the study sample;
4. Collecting and analyzing bulk samples;
5. Collecting and analyzing air samples; and
6. Reporting results to appropriate school officials.

These series of events basically occurred in the order presented above. This section will describe in detail each of these events.

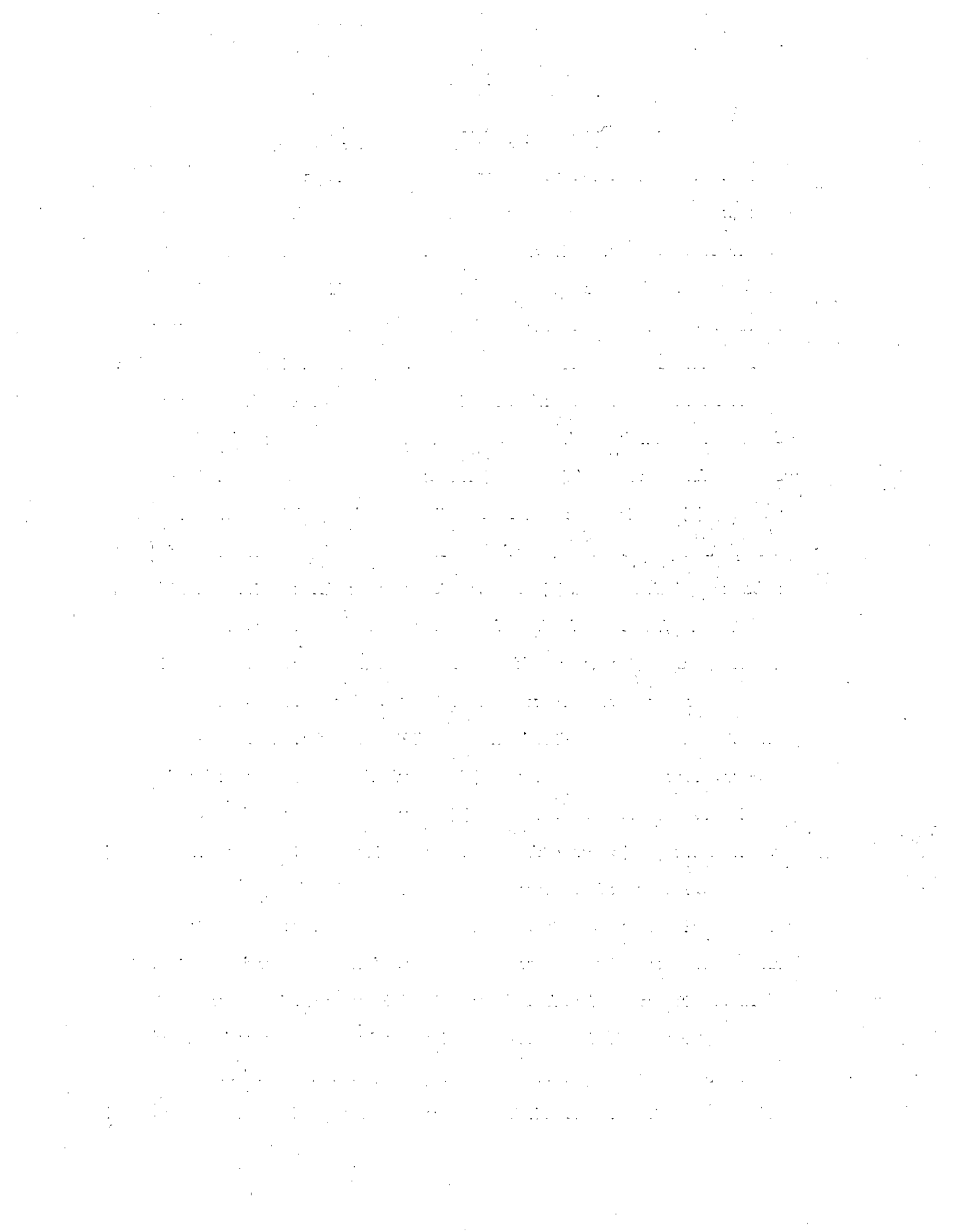
Pilot Study

Prior to field work, Program staff reviewed and compiled relevant existing literature, prepared "field" data collection forms, prepared program promotional materials, and purchased and assembled necessary "field" equipment. Concurrent with these tasks, Program staff contacted and met with selected individuals from Colorado's State Department of Education and established working definitions and arrangements. Due to preparations and constructive interactions with state department personnel, it was not necessary for SAT Program staff to solicit pilot study sites. State Department of Education personnel broadcasted the existence, intent and purposes of the Safe Asbestos Treatment Program throughout the state and in a very short period of time Program staff began receiving requests from district superintendents to be included in the

the study's efforts. Program staff continued to receive these requests throughout the study period and were able to respond to the majority of them. However, for the purposes of a "pilot study" four school districts were selected. From these four districts, 16 schools were surveyed with a total of 32 bulk samples collected and analyzed. In all cases, an educational session was arranged and delivered prior to the collection of bulk samples. These sessions included the district superintendent, other district level officials, school building principals, and building maintenance personnel. Based on experiences in the "pilot study": (1) educational presentations and materials were refined, (2) "field" data collection forms revised, (3) sample collection equipment and procedures identified and defined, (4) sample analysis procedures defined, and (5) the format for reporting results established.

In addition to assisting with the promotion of the Program and carrying out the Program's "pilot study", state department personnel provided Program staff information upon which the "study sample" was selected. This information included: (1) appropriate data from EPA's voluntary asbestos survey, (2) descriptions of the organization of Colorado public education, and (3) appropriate descriptions of school buildings (construction, data, remodelling data, floor plans, etc.).

In school districts where the number of facilities selected by the random sample approached the total number of schools in the district, all schools were surveyed for asbestos materials as a service to the district. In other districts where officials requested SAT Program staff to survey buildings, this was also performed as a service to the district. Appendix H contains a breakdown by school district for surveys conducted in the pilot study, the "study sample", and other schools.



Selection of Study Sample

(A detailed description of procedures utilized and of the resultant "study sample" are provided on pages 3-5 of this report. Further information is provided in Appendix B).

Educational Sessions and Materials

(A discussion of educational sessions delivered and accompanying materials utilized is provided on pages 6-8 of this report. Further descriptions of these sessions and materials are provided in Appendices C, D, E, and F.)

Collection and Analysis of Bulk Samples

Surveys consisted of a walkthrough, visual inspection, and evaluation of the potential exposure hazard from possible asbestos-containing materials. These surveys were carried out in all areas of schools: hallways, gymnasiums, auditoriums, cafeterias, offices, boiler rooms, storage spaces and the spaces above lowered ceilings.

The evaluation from "Sample Collection Data" and evaluation criteria "An Evaluation Aid in Assessing Potential Asbestos Exposure" are presented in Appendix I and were designed to reflect the potential exposure hazard that might exist by determining where asbestos materials were and their condition. Six criteria were evaluated: condition, accessibility, air movement, activity, friability and percent asbestos. Condition was a reflection of the degree of deterioration and/or damage of the materials. Accessibility was the relative ease with which asbestos containing material may be reached or disturbed. Air movement reflected the degree to which asbestos fibers might accumulate at a site. Activity was the potential, because of room use, for damage to occur to asbestos-containing materials. Friability was the ease with which the material

could be broken or crumbled. Finally, percent asbestos was the amount of asbestos present in the material. This was obtained from laboratory analysis of bulk samples. In each of the categories, a number (from one to three in the first five, one to four in "percent asbestos") was assigned to reflect the exposure potential of each. The lowest number reflected the least potential while the highest number indicated the greatest exposure potential for that criterion. The total of the assessed value for each of the above criteria reflected the overall exposure potential.

At the time of the survey, additional information about the school was obtained (see "General Data" Appendix J). This included the number of pupils in the school, the number of teachers and staff (full and part-time), building usage (standard curricular use, extra-curricular use and community and other use) and building construction data were confirmed (original construction data and dates of additions and remodelling). If available, the names and addresses of architects and contractors for original and subsequent construction were also obtained.

During the survey bulk samples were taken from all materials which might have contained asbestos. Samples were taken by removing a portion of the material with a scalpel. The samples included all layers from the outside of the material to the substrate. Samples were placed in labelled, clean, 35 mm film canisters. All samples were taken in as inconspicuous a place as possible, and precautions were taken to avoid inhalation of dust.

The bulk samples were first screened using K² Asbestos Screening Test. This is not actually a test for asbestos, but for magnesium and iron. It is a colorimetric test and yields a blue color for the magnesium

test and a red color for the iron test. The K² Test is described in detail in Appendix K.

For samples which were positive for either magnesium or iron, a portion of the sample (approximately one-half of whatever remained) was placed into another labelled, clean, 35 mm film canister and sent to an outside laboratory for polarized light microscopy. This procedure confirmed the presence of asbestos, determined the type of asbestos and estimated the percent of asbestos in the sample. Based on the building survey analysis and reports from the polarized light analysis for percent asbestos, the exposure potential index was calculated. Values of six to eight would indicate that exposure was negligible or that no potential for exposure existed. In such cases no action would be necessary beyond a continuing inspection program to monitor the situation. Higher values, from nine to 19, would indicate that some corrective action (i.e., removal, encapsulation or enclosure of the material) should be considered.

Data collected by the above described procedure were analyzed to determine the prevalence of asbestos materials in Colorado public schools, the prevalence of sprayed-on asbestos materials in Colorado public schools and secondary information concerning the schools and analysis techniques.

Collection and Analysis of Air Samples

This study was designed and performed to measure the airborne concentrations of asbestos in six Colorado public school facilities with sprayed-on asbestos materials. (Facilities were designated by numbering from 1-6.) The presence, type and percent of asbestos in sprayed-on materials had been confirmed by polarized light by an outside laboratory.



Appendix L contains descriptions of percent asbestos, damage to material and activity levels for each facility. From two to five air samples were taken inside of the buildings depending on building size and extent of sprayed-on materials. In each case, one sample was taken outside of the building to determine ambient community levels of asbestos.

Duplicate samples were collected on Millipore AA 37 mm cellulose ester filters with 0.8 μm sized pores in a Gelman three piece polystyrene cassette (field monitor). Both inside and outside air samples were taken in the "open faced" position with the monitor top off.

Air sampling pumps for Facilities 1 and 2 (see Appendix L) were Bendix Sequential Samplers altered to bypass the timing mechanisms. Facilities 3 to 6 (see Appendix L) were sampled with pumps obtained from Research Appliance Company (RAC) with General Electric motors and Gas pump mechanisms. Duplicate samples were drawn by placing a T connection in line or by use of matched critical orifices connected to a common chamber on the RAC pumps. The critical orifices and common inlets to the pumps were obtained from RAC. For all pumps the flow rates ranged from 10.9 to 13.5 L/min. Because even small leaks in the cassettes or tubing upstream of the orifice caused a noticeable change in flow rate, all pumps were calibrated before and after each sampling period with the respective field monitors and filters in place.

An initial attempt was made to use phase contrast to count all fibers visible in the entire thickness of the filter to account for fibers deeply embedded by the high face velocity of 23 cm/sec. The National Institute of Safety and Health (NIOSH) procedure for asbestos counting requires particles of a 3:1 aspect ratio (length to width), greater than 5 μm in length, and lying in the upper 15 μm of the filter

depth be counted by phase contrast microscopy. This procedure was followed except that all particles with 3:1 aspect ratio were counted regardless of length throughout the entire 150 μm depth of the filter and not just the upper 15 μm . This procedure was abandoned when two counters ranked "Proficient" by the NIOSH Proficiency Aptitude Testing Program could not agree within 15% and when four counters could not agree on the same field focused through the entire filter.

Seventy-eight samples and two blanks were then mailed to an American Industrial Hygiene Association (AIHA) accredited laboratory for asbestos counting by the NIOSH procedure. This method does not distinguish asbestos from other fibers. Polarized light was coupled to the phase contrast for additional analysis on two filters.

Scanning and transmission electron microscopy were also performed on selected samples. For these analytical techniques the filters were ashed and redeposited on Nuclepore filters by an outside laboratory. A quarter section of each filter was placed in an individual 3/8 inch by 2 inch tube which had been freshly cleaned with acid and rinsed with deionized, double distilled water that had been filtered through a 0.1 μm polycarbonate filter (D-2D-F water). Three tubes containing samples plus one tube with a blank supplied by the laboratory were ashed for two hours in the LFE low temperature oxygen plasma oven model LTA-504. The oven chamber was acid washed and rinsed with D-2D-F water just prior to the ashing procedure. At the end of the two hour ashing period the tubes were half filled with freshly prepared D-2D-F water and placed in an ultrasonic bath for three minutes to disperse the ash. The suspension plus tube washings were placed in the collection funnel of a suction

filtration device. After collection was complete, suction was applied to filter the ash onto a 25 mm, 0.1 μm pore size Nuclepore polycarbonate filter which had been backed by a 5 μm size Millipore filter to assure even deposition. After drying Nuclepore filters which were being returned to this laboratory for scanning electron microscopy were carbon coated to a depth of approximately 100 Angstroms to hold fibers in place during transport.

When filters were received by the in-house laboratory for scanning electron microscopy, a strip from the edge to the center of each filter was mounted in three sections on copper tape on a stub and recoated with gold palladium to a depth of approximately 200 Angstroms. Analysis was then performed on a Hitachi HHS-2R scanning electron microscope at a magnification of 1500 and a working distance of 5 mm. Scanning electron microscopy does not distinguish asbestos from other fibers. Acicular particles with a 3:1 aspect ratio were counted. A total of 10 fields was counted on each section giving a total of 30 counting fields from the edge to the center of the filter.

Fourteen Nuclepore filters remained at the outside laboratory for transmission electron microscopy. To distinguish asbestos from other fibers, selective area electron diffraction and energy dispersive X-ray analysis were also performed. Transfer to the EM grid was done in a Jaffe Wick Washer with chloroform as the solvent. Analysis was performed on a JOEL-100C Analytical Electron Microscope with a Kevex X-ray Detector and Tracor-Northern NF880 X-ray Analyzer. Screen magnification was 16,000. The minimum count was 10 grid openings or 100 objects. Single asbestos fibers with a 3:1 aspect ratio were counted. Selected area electron diffraction and energy dispersive X-ray analysis were also performed on each visible object.

No attempt was made in the design of this study to compare analysis techniques, and therefore, multiple analysis was not performed on any one sample. Due to cost factors duplicate sample analysis was performed only by phase microscopy. Results reported as fibers per filter or asbestos fibers per filter were converted to fibers or asbestos fibers per cubic centimeter of air.

Report to School Officials

Reports were sent on the results of the building surveys to the contact person for each school district surveyed. It was recommended that corrective actions be based on the building survey reports and not on air sampling. Reports on the air sampling results were also sent to district officials, but the limitations of each analysis technique were fully explained.

RESEARCH RESULTS AND DISCUSSION

This section presents the results of the two research projects conducted by SAT Program staff: (1) the prevalence and condition of asbestos-containing materials in Colorado schools, and (2) the levels of airborne asbestos in selected Colorado public school facilities with sprayed-on asbestos material.

Prevalence and Condition of Asbestos-Containing Materials

Thirty-one of the 41 schools surveyed had asbestos-containing materials in one or more locations. Of those 31, 10 schools had sprayed-on asbestos ceilings. Table II shows the number of schools in each region that had asbestos-containing materials and/or sprayed surfaces.

TABLE II

NUMBER OF SCHOOLS WITH ASBESTOS AND SPRAYED ON ASBESTOS,
COLORADO PUBLIC SCHOOLS, FALL AND WINTER 1980

Region	Number of Schools Sampled	Number of Schools With Asbestos	Number of Schools With Sprayed-on Asbestos
I	23	16 (70%)	7 (30%)
II	3	2 (67%)	0
III	6	5 (83%)	2 (33%)
IV	4	4 (100%)	1 (25%)
V	5	4 (80%)	0
TOTAL	41	31 (76%)	10 (24%)

Based on the number of schools found to have asbestos-containing materials in the random sample, it was estimated that between 63% and 89% (95% confidence interval) of the public schools in Colorado may .



have friable asbestos-containing materials. Ten percent to 38% (95% confidence interval) of Colorado schools may have sprayed-on materials which contain asbestos.

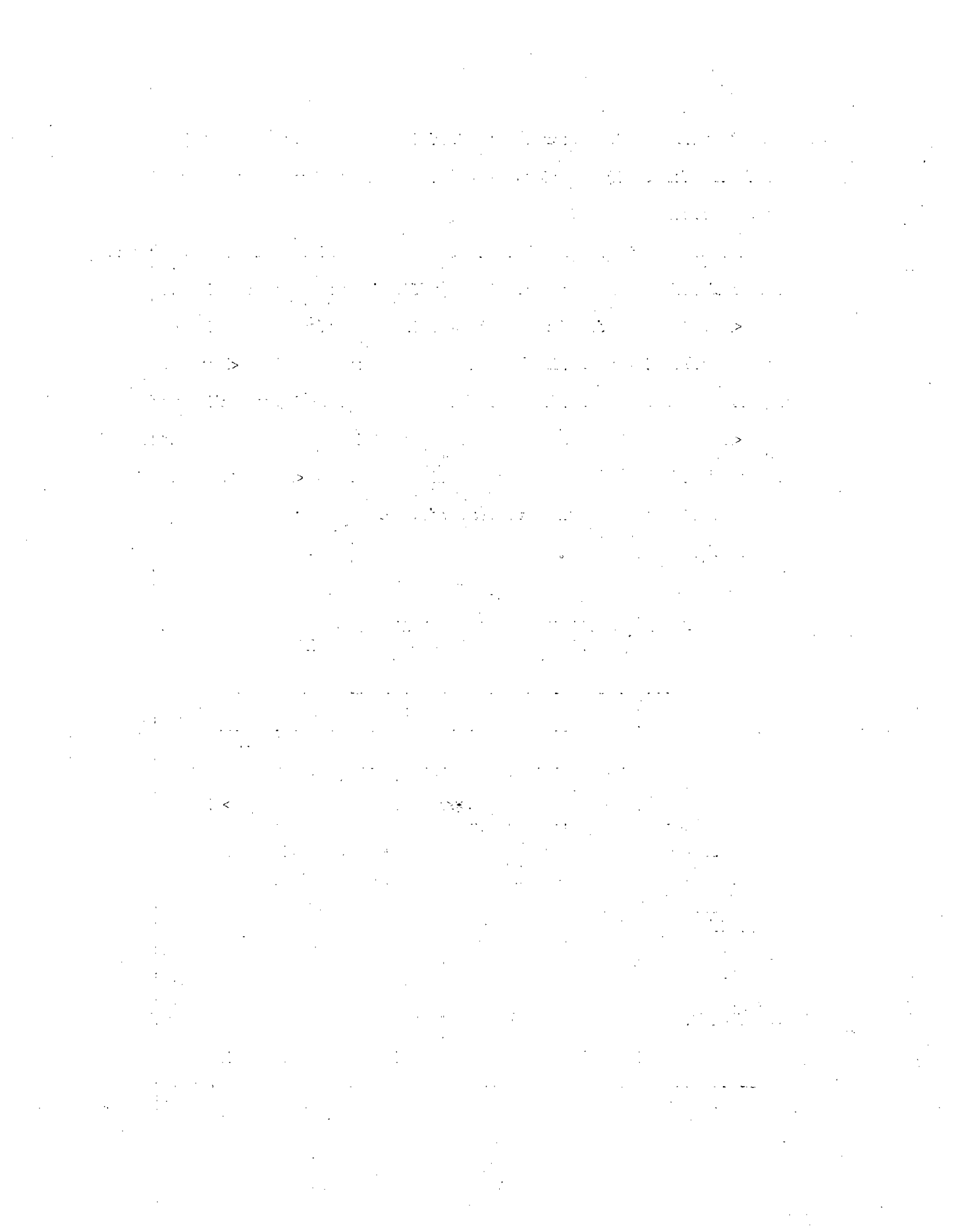
The types of asbestos found included chrysotile, actinolite, amosite and crocidolite. The percent of chrysotile in sprayed materials ranged from <1 to 30%. Actinolite was frequently found with chrysotile in sprayed materials, but only in small amounts, ranging from <1 to 2%. In other asbestos-containing materials, the amount of chrysotile varied from <1 to 95%. Amosite content ranged from 1 to 60% of the materials, and crocidolite was found in very small quantities, <1 to 2%. Table III shows the number of samples that contained the different forms and combinations of asbestos.

TABLE III

ASBESTOS-CONTAINING SAMPLES BY TYPE OF ASBESTOS,
COLORADO PUBLIC SCHOOLS, FALL AND WINTER 1980

Type	Number of Samples								Total
	Sprayed				Other				
	1- 10%*	11- 25%	26- 50%	>51%	1- 10%	11- 25%	26- 50%	>51%	
Chrysotile	8	--	--	--	5	--	10	14	39
Amosite	--	--	--	--	3	--	1	--	4
Chrysotile- actinolite	2	--	--	--	--	--	--	--	2
Chrysotile- amosite	--	--	--	--	4	2	2	1	9
Amosite- crocidolite	--	--	--	--	--	--	--	2	2
TOTAL	10	0	2	0	12	2	13	17	56

*Percentage ranges used in the "evaluation of potential asbestos exposure"



The distribution by grade level of the number of schools with asbestos-containing materials and with sprayed-on asbestos is presented in Table IV.

TABLE IV
NUMBER OF SCHOOLS WITH ASBESTOS AND SPRAYED-ON ASBESTOS
BY GRADE LEVEL, COLORADO PUBLIC SCHOOLS,
FALL AND WINTER 1980

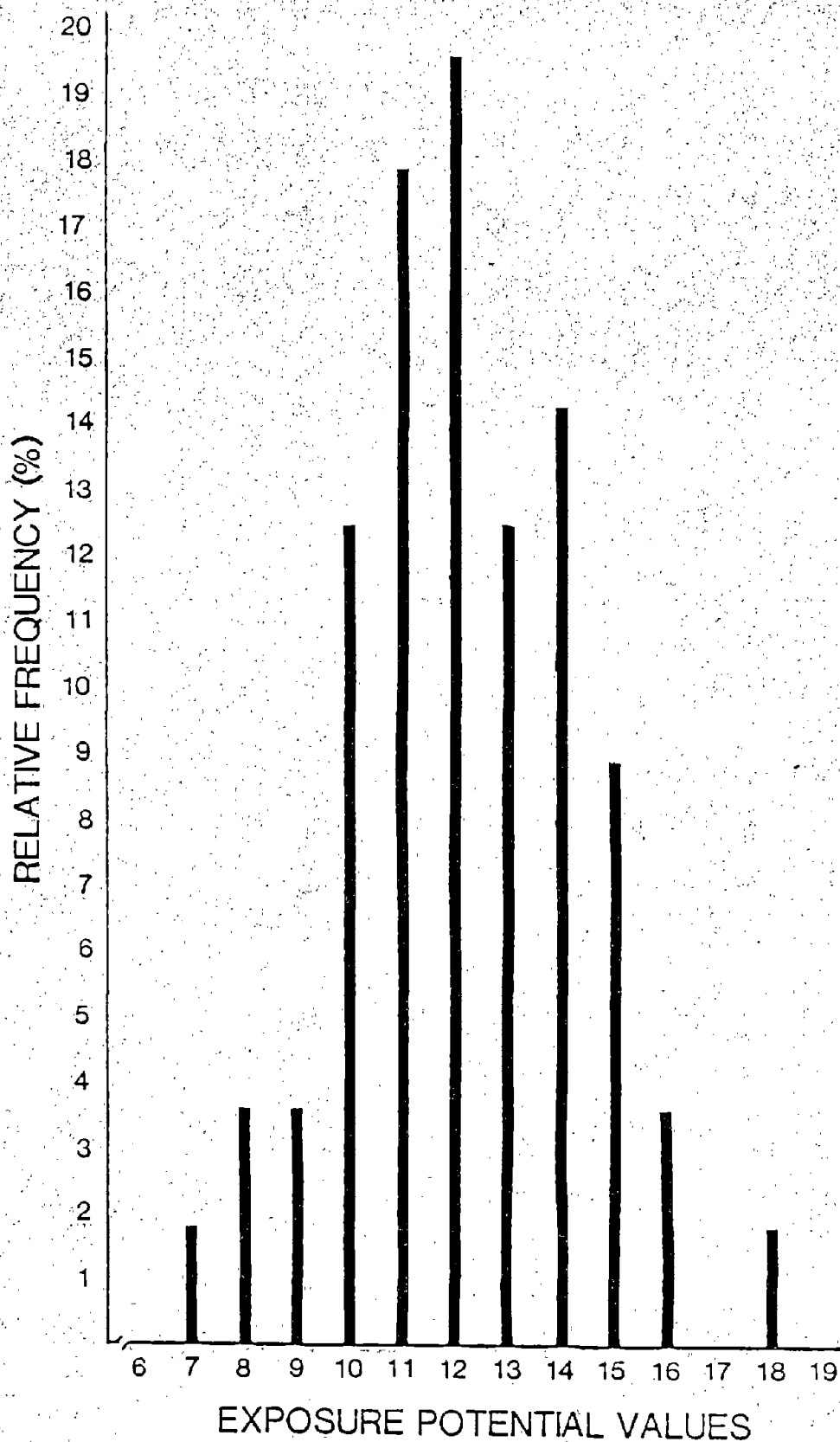
Grade Level	Number Sampled	Number With Asbestos	Number With Sprayed-on Asbestos
Elementary	25 (3.4%)	18 (73%)	5 (2%)
Junior High	7 (3.3%)	5 (71%)	0
Senior High	8 (3.2%)	7 (87%)	4 (50%)
Other	1 (1.5%)	1	1

The procedure used to evaluate material condition and exposure potential (see Appendix I) could yield a final figure which ranged from 6 to 19. This exposure quotient was calculated for each bulk sample collected. Figure 2 is a distribution of the relative frequencies for the calculated exposure potential values. A potential exposure value from six to eight indicated that no action need to be taken, while one from nine to 19 indicated that some corrective action was required. The potential exposure values calculated by Program staff indicated that action was required in 53% (95%) of the areas sampled in this study.

Air Sampling

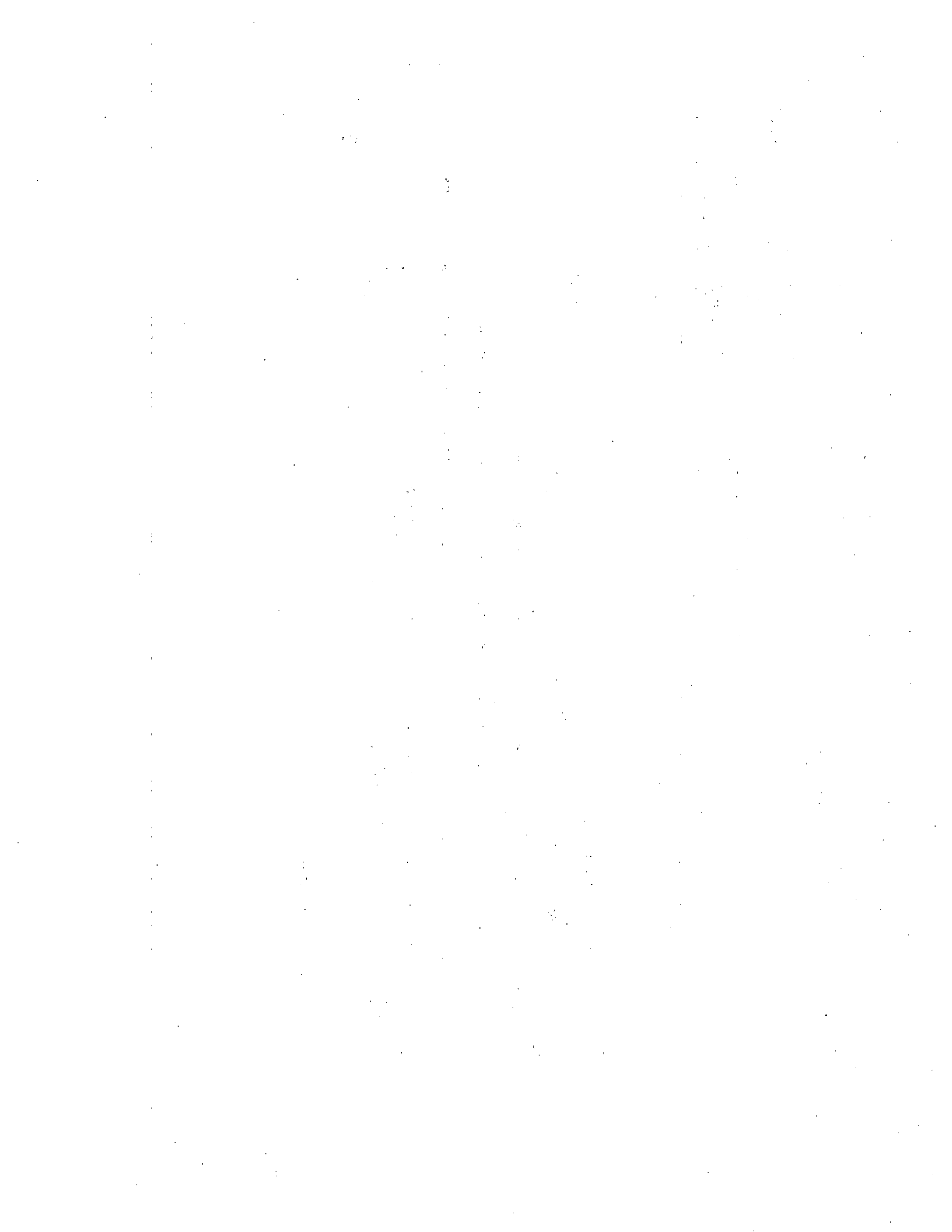
The amount of airborne asbestos documented in the school depended on the analysis technique and varied considerably between the three techniques employed.





FREQUENCY OF EXPOSURE POTENTIAL VALUES, COLORADO PUBLIC SCHOOLS, FALL AND WINTER, 1980

FIGURE 2



Phase Contrast Microscopy Results

Of 78 samples and two blanks analyzed by phase contrast microscopy at 400X, fiber counts on 57 samples and two blank filters were below the detectable limit of 4500 fibers/filter. The remaining 21 samples yielded concentrations in the thousandths of a f/cc. Because of the high error in phase counting, concentrations in this range are considered valid. The error factor ranged from 65% to >81% at the 95% confidence level and all detectable concentrations were in the thousandths of a f/cc.

Of the two sample filters analyzed by both polarized light and phase contrast, one filter showed 23,000 total fibers by phase contrast. When placed under polarized light, only cellulose and no asbestos fibers were found on this filter. (The other filter yielded a count of less than 4500 fibers by phase contrast and no asbestos by polarized light.)

Comparison of Duplicate Samples

A paired t-test was performed on the phase contrast microscopy data to determine if the procedure generated results which were precise. Filter counts from duplicate samples were converted to fibers per liter for comparative purposes. Table V is a summary of fiber per liter concentrations for duplicate samples. The t-test probability value was 0.07, and a probability of 0.05 had been set as the value for rejection of duplicate equality. The test for duplicity was not strong considering the p-value of 0.07 and counting error of at least 50 percent. Phase contrast microscopy displayed some measure of precision for this study.

Scanning Electron Microscopy (SEM) Results

One group of filters which had been ashed together in the same chamber was discarded because of suspected contamination. This was

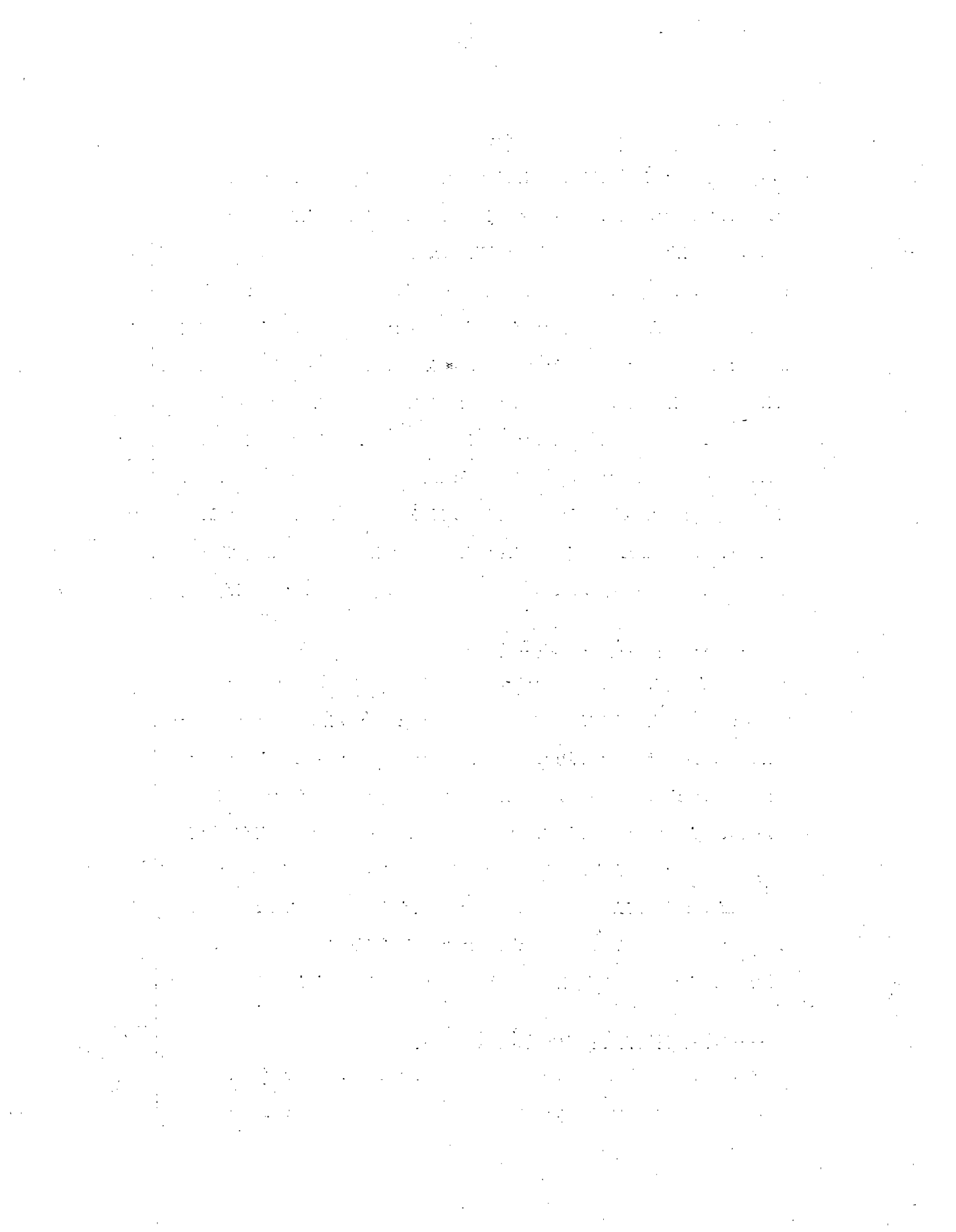


TABLE V

COMPARISON OF DUPLICATE SAMPLES ANALYZED FOR FIBERS
BY PHASE CONTRAST MICROSCOPY AND EXPRESSED IN FIBERS PER
LITER FROM COLORADO PUBLIC SCHOOLS, WINTER AND SPRING 1981

Facility	Concentration of Duplicates (f/liter)	
	Higher Duplicate	Lower Duplicate
3	3.0	2.7
	2.6	2.6
	2.9	2.9
	2.8	2.0
4	3.2	1.8
	5.3	3.8
5	1.3	1.1
	1.9	1.6
	2.9	1.6

the first group ashed in the chamber, counts were all equal and the highest of all filter counts by SEM (148,000 fibers per filter). TEM analysis (counts only asbestos fibers) of one of the blanks showed 10,000 asbestos fibers on the filter. Contamination of the ashing chamber was suspected to be by a non-asbestos filter. SEM may be more susceptible to contamination than the TEM method used since all fiber types are counted.

SEM counts at 1500X on the remaining blanks yielded an average of 57,000 fibers per filter which was deducted from the remaining sample filter counts before calculation of concentrations. Resulting concentrations ranged from less than could be detected by the method to 0.059 fibers per cubic centimeter of air (f/cc). Individual results are in Appendix L. Multiple air samples were analyzed by SEM for the same facility. Average building air concentrations of fibers is shown in Table VI and ranged from less than a thousandth of a f/cc to 0.025 f/cc.

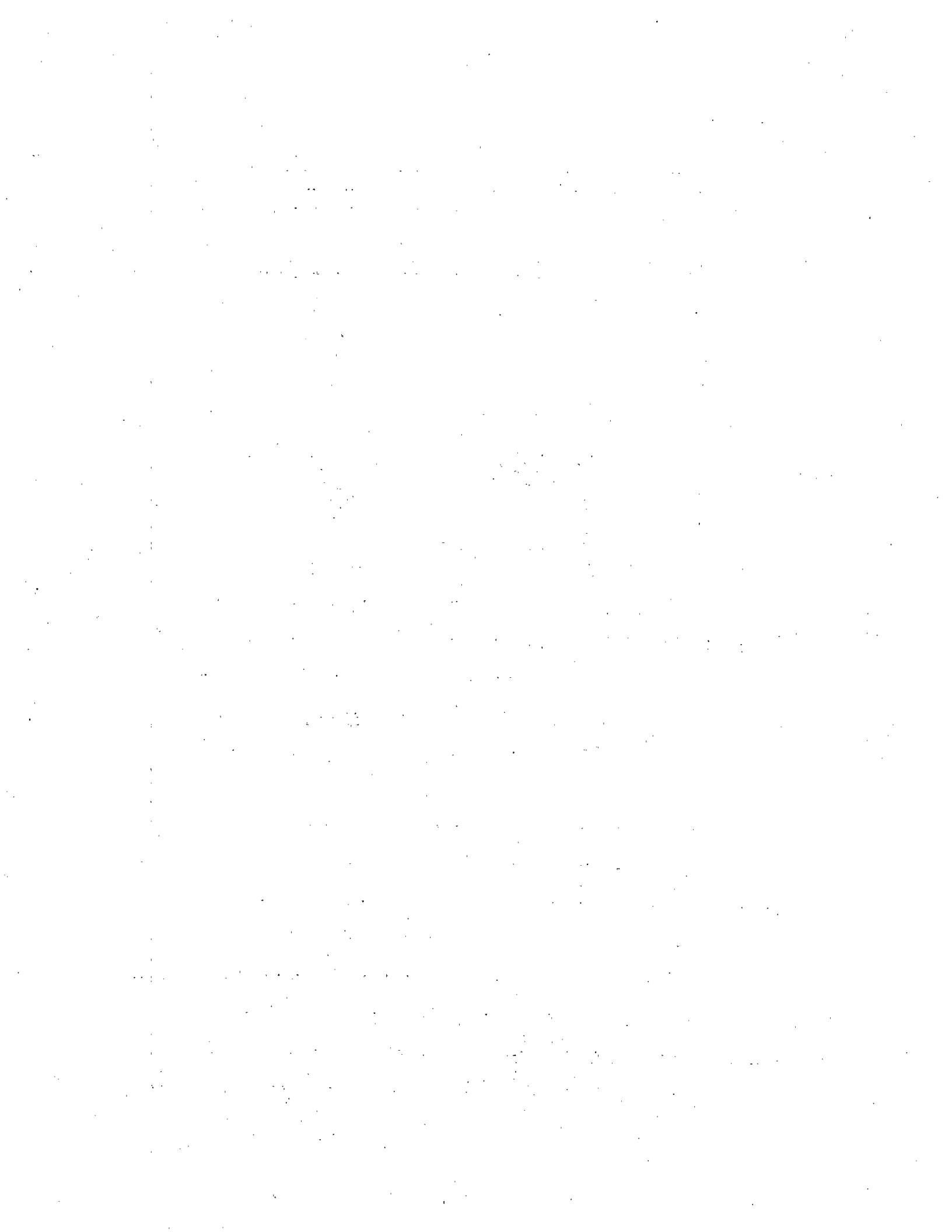


TABLE VI

AVERAGE INSIDE CONCENTRATIONS DETERMINED BY
SEM ANALYSIS FOR SIX COLORADO PUBLIC SCHOOL
FACILITIES, WINTER AND SPRING 1981

Facility	Average Inside Concentration (Fibers/cc)	(n)
1	0.008	(1)
2	<reportable*	(1)
3	0.005	(2)
4	0.025	(3)
5	0.005	(4)
*6	<reportable	(3)

*Less than a thousandth of a f/cc.

Transmission Electron Microscopy, Selected Area Electron Diffraction,
and Energy Dispersive X-Ray Results

The average of counts done at 16,000X on blanks was 17,000 fibers per filter. Both asbestos fibers and unidentifiable fibers were counted. The mean blank count was subtracted from each sample filter count before calculation of the concentration. Individual results are in Appendix L and ranged from 0.001 to 0.782 asbestos f/cc.

For each facility the outside measurement was subtracted from respective inside measurements to adjust for differences in community asbestos air pollution. Inside-minus-outside concentrations ranged from 0-0.739 asbestos f/cc and is included along with the inside and outside concentrations by facility in Table VII.

By a two way analysis of variance test, there was found to be a statistical difference between the average of measurements taken at each

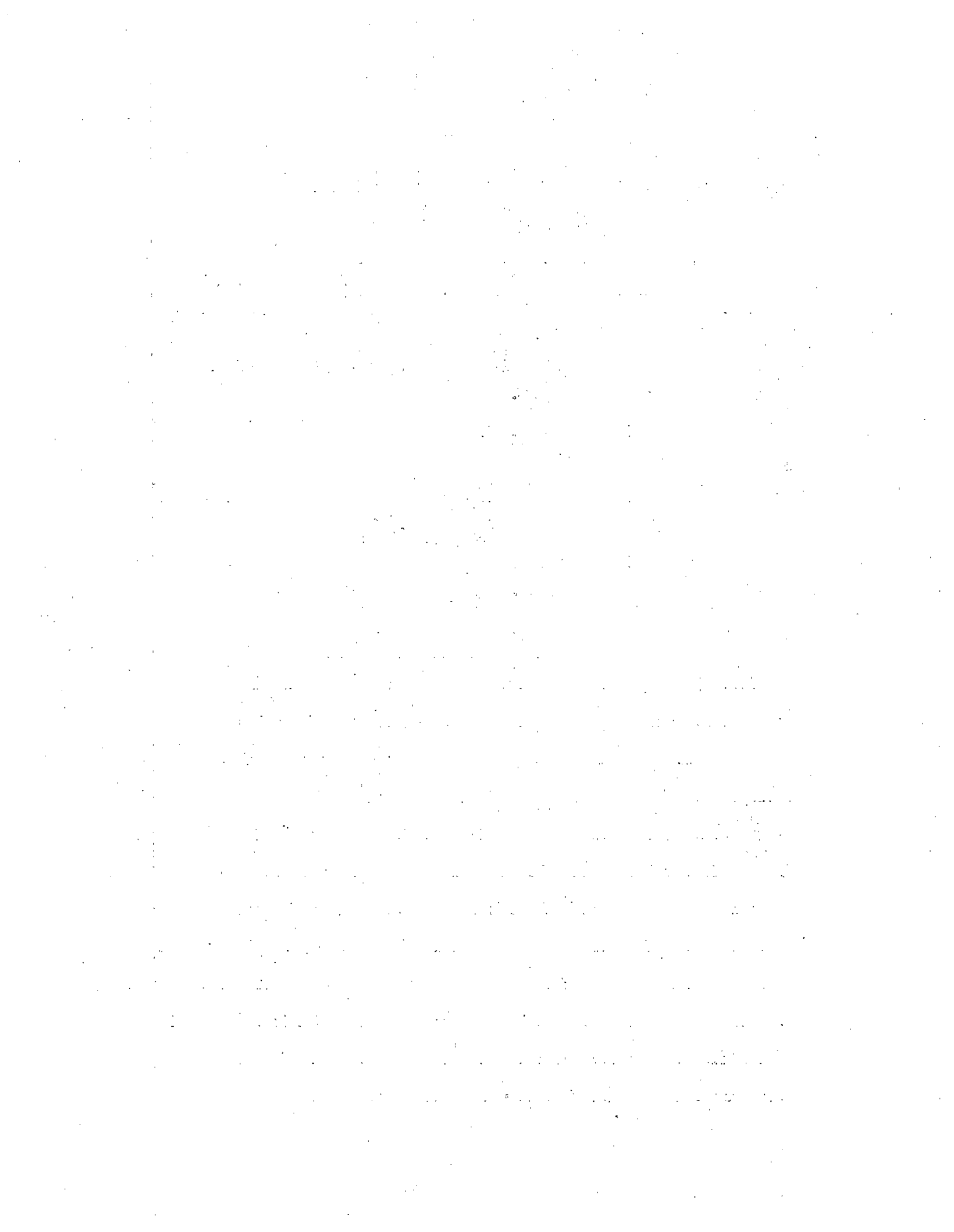


TABLE VII

SUMMARY OF ASBESTOS CONCENTRATIONS (f/cc) DERIVED FROM TEM ANALYSIS FOR FIVE COLORADO PUBLIC SCHOOL FACILITIES, WINTER AND SPRING 1981

Facility	Sampling Day	Concentration (asbestos f/cc)		
		Inside	Outside	Inside-Outside
1	1	0.143	0.012	0.131
		0.048	0.012	0.036
3	1	0.021	0.050	-0-
		0.298	0.050	0.248
4	1	0.061	0.043	0.018
		0.782	0.043	0.739
5	1	0.004	0.004	-0-
		0.006	0.004	0.002
6	2	0.007	0.001	0.006

facility ($p = 0.03$; 4, 8) but not between the mean of inside concentrations compared to the mean of outside concentrations ($p = 0.08$; 1,8). A probability of 0.05 had been set as the value for rejection of the null hypothesis. Because the calculated p -value of 0.08 for mean inside compared to mean outside was so close to the rejection value and because the population was small, it was decided to partition the error source of variation to determine if there was a consistent difference between the inside and outside concentrations across the facilities. A low F -value of 0.25, with 4,4 degrees of freedom was calculated for the comparison of inside to outside measurements on a facility-to-facility basis and demonstrated that the difference between inside and outside concentrations was consistent across the five facilities.



TEM results were also viewed by first taking the average of inside asbestos concentrations then deducting the outside concentration. This tabulation diminishes the effect of different activity levels and is in Table VIII. This approach yielded concentrations ranging from 0.001-0.379 asbestos f/cc.

TABLE VIII.

SUMMARY OF AVERAGE INSIDE, OUTSIDE, AND AVERAGE INSIDE MINUS OUTSIDE CONCENTRATIONS (ASBESTOS f/cc) AS DETERMINED BY TEM FOR FIVE COLORADO PUBLIC SCHOOL FACILITIES, WINTER AND SPRING 1981

Facility	Concentration (asbestos f/cc)			
	\bar{X} Inside	(n)	Outside	\bar{X} Inside Minus Outside
1	0.096	(2)	0.012	0.084
3	0.160	(2)	0.050	0.110
4	0.422	(2)	0.043	0.379
5	0.005	(2)	0.004	0.001
6	0.007	(1)	0.001	0.006

Analytical Techniques

Phase contrast microscopy using the NIOSH techniques yielded little information concerning airborne asbestos levels for all sizes of fibers. Only fibers longer than 5 μm , wide enough to be resolved by the microscope at 400X, and lying in the upper 15 μm of the filter were counted. All fiber types were counted since phase contrast alone cannot distinguish asbestos. This is an important point since cellulose and other organic fibers are often incorporated into sprayed-on materials.

Data from scanning electron microscopy contributed little more information on asbestos levels in schools. Analysis was performed at



1500X, and smaller fibers were counted, but asbestos was still not distinguished from other fibers.

Transmission electron microscopy coupled to selected area electron diffraction and energy dispersive X-ray analysis was the only technique used which had the capability of generating information on air contamination by asbestos fibers of even small sizes. It was felt that this technique offered the best potential for accurate analysis of environmental air samples for asbestos. Many problems were encountered in the preparation of filters for analysis, and these problems need to be clarified and corrected. A standardized methodology is needed for analysis of environmental air samples for asbestos.



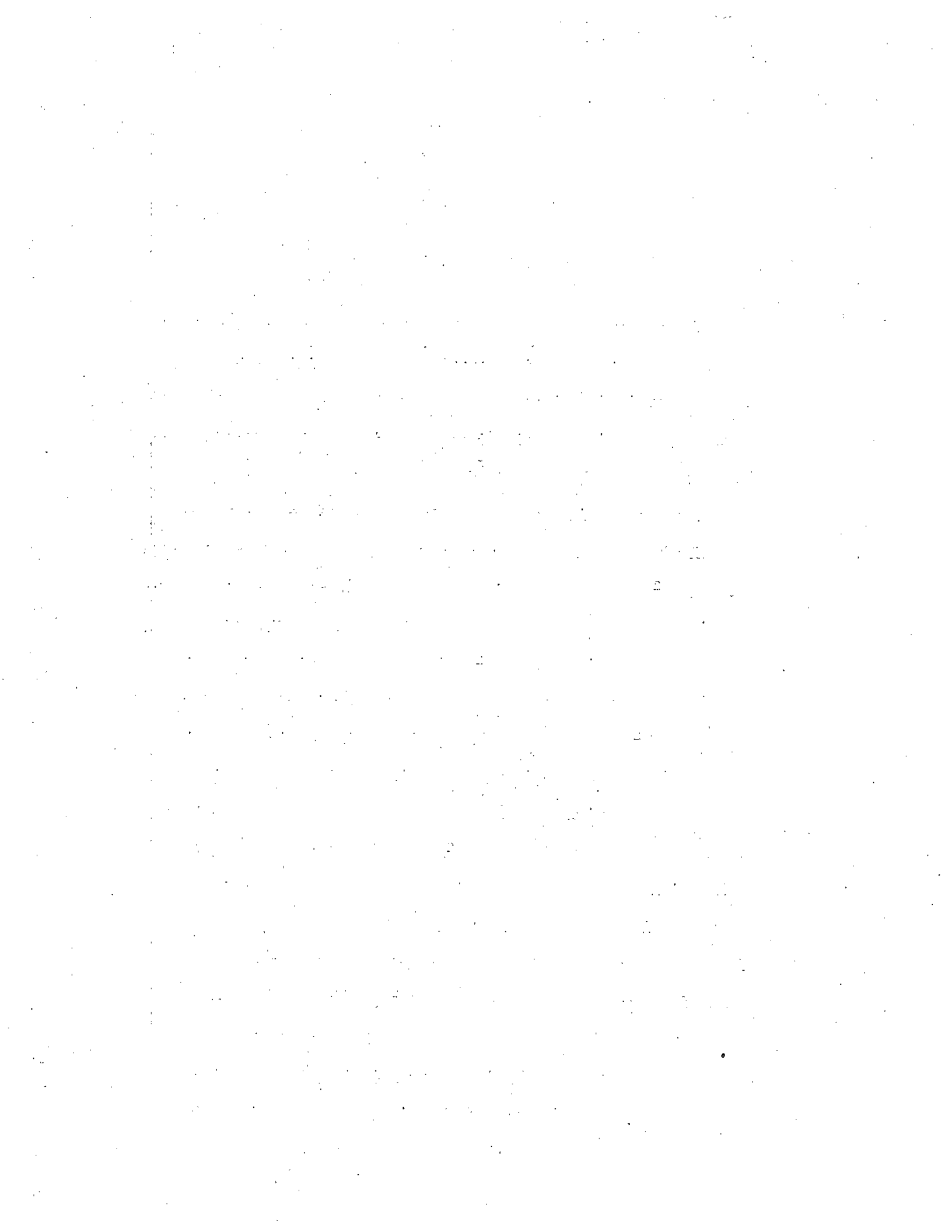
SUMMARY AND RECOMMENDATIONS

Summary

The primary purpose of the Safe Asbestos Treatment Program (SAT) was to conduct research into the prevalence and condition of asbestos-containing materials in Colorado public schools and to document the levels of airborne asbestos in several Colorado public school facilities which contained sprayed-on asbestos material.

One hundred and thirteen bulk samples were collected from a random sample population of schools which represented 3.2% of Colorado's public schools. The K² Asbestos Screening Test gave a negative result for iron and magnesium on 12 of the bulk samples collected. Confirmational analysis on those samples positive by the K² Test was by polarized light microscopy. This technique confirmed that asbestos was present in 56 of the samples positive by the K² Test. At the 95% confidence level, it was estimated that between 63% to 89% of Colorado's public schools may contain some type of asbestos materials and that between 10% to 38% may contain sprayed-on asbestos materials. The K² Test was not recommended for use by school officials because of the high number of false positives and the use of strong acids as reagents.

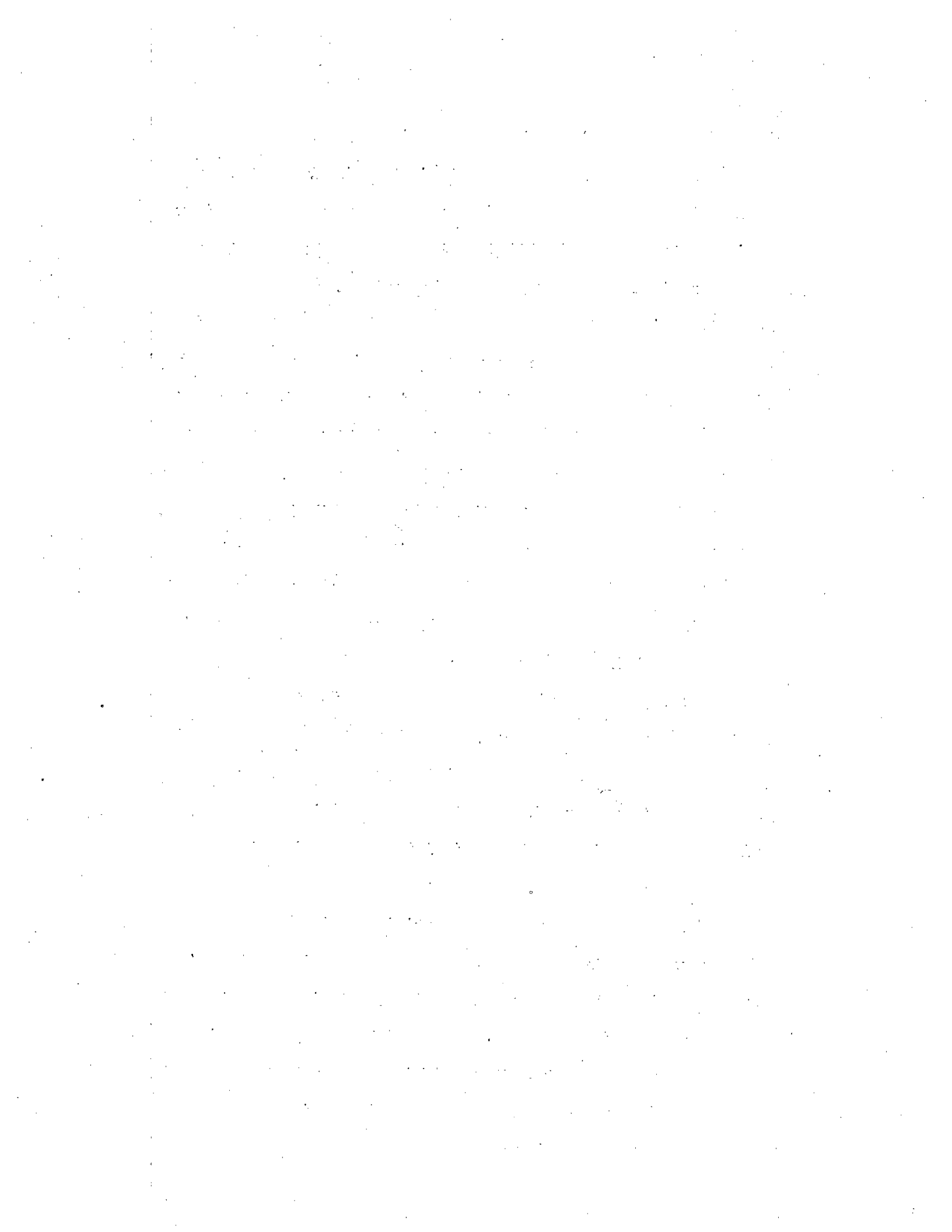
Air samples were taken inside and outside of six Colorado school facilities with sprayed-on asbestos materials. All samples were analyzed by phase contrast microscopy and selected samples were analyzed by scanning electron microscopy (SEM) and transmission electron microscopy coupled to selected area electron diffraction and energy dispersive X-ray



analysis (TEM-SAED-EDXA). The levels of airborne asbestos found for the buildings depended on the analysis technique. Results from phase contrast yielded concentrations in the thousandths of a fiber per cubic centimeter of air (f/cc) or less. Concentrations determined from SEM were in the hundredths of a f/cc or less. TEM-SAED-EDXA gave concentrations in the tenths of an asbestos f/cc. When the outside concentrations were subtracted from the respective average concentrations within the buildings, two schools showed airborne asbestos levels in the tenths of an asbestos f/cc. TEM-SAED-EDXA was felt to be the best analytical approach for environmental asbestos air samples because small fibers were counted and asbestos fibers were specifically identified.

Prior to conducting the research, a pilot study was carried out in 29 Colorado schools. Through this experience the procedures, methods, and materials used with the "study sample" were developed and refined. SAT Program staff also provided educational sessions and talks on asbestos for 290 participants primarily from the construction industry and school maintenance departments; however, school district officials were also present at these sessions. Two pamphlets and seven newsletters were written by SAT Program staff. To date, these materials have been distributed to approximately 15,000 individuals both in Colorado and throughout the United States.

Additionally, SAT Program staff participated in several media events. The SAT Program and staff efforts were broadcasted via local TV (three Denver stations) and numerous radio stations. Stories were also printed in Denver's two leading newspapers, and articles appeared in virtually every newspaper in the State. It is difficult to evaluate the specific outcomes of media coverage; however, at a minimum this type of coverage served as an "awareness building" tool.



An extremely positive outcome of the activities carried out by SAT Program staff was the degree of interest generated among the construction industry. Due to SAT Program activities, Colorado now has several contractors who are prepared to conduct asbestos treatment or removal work. This was no menial task, in that years of myth needed to be scrubbed away and new skills taught. During the study period, SAT Program staff responded to 28 requests from contractors involved in asbestos treatment or removal projects. Presently, these types of requests are received on a regular basis.

Recommendations

This section presents suggestions and recommendations that pertain to: (1) the continuance of efforts and activities initiated within the SAT Program, and (2) other issues related to the asbestos problem in this nation's school buildings.

Continuance of SAT Program Efforts

The activities of the SAT Program were funded for a period of one year. Consequently, time and funds defined the delimitations of this study. Though much was accomplished during this time period, the task of addressing the asbestos problem in Colorado school buildings is far from finished. The obvious recommendation drawn from this situation is the continuance of the work initiated by SAT Program staff. It is suggested that future efforts essentially duplicate the SAT Program. However, there are a couple of exceptions. For example, Program staff used the K² Test as a preliminary screening method for the analysis of bulk samples (see Appendix K for a detailed description of a K² Test). The K² Test will give false positives. Out of 113 bulk samples tested with this method,



45 gave false positive readings. Part of this discrepancy may be attributed to difficulty in interpreting various shades of blue and red and to interference from other colors (yellow or green) which are produced. In addition, the test is described as one which may be used in the field. Use in the field, however, would be difficult due to the strong acids, especially hydrofluoric, and bases which are used, and the associated disposal problems once the test is completed. The idea of a relatively quick field testing for asbestos-containing materials is attractive, however, the K² Asbestos Screening Test is not recommended for this purpose.

An additional refinement of the SAT Program concerns the pumps used for air sampling. Two matched critical orifices were used to maintain a constant flow rate of 10 liters per minute. These orifices were attached to the intake ports on the air sampling pumps. Because the capacity of the pumps used greatly exceeded that needed for the proper use of the two critical orifices, several problems resulted. First, downstream pressure was six times greater than upstream pressure when approximately a 2:1 ratio was needed to maintain 10 L/min. Because the pressure differential was so great, even small leaks in the cassettes or tubing upstream of the orifice caused a noticeable change in the flow rate, and pumps had to be pre and post calibrated with the respective collection filter and cassettes in place. Secondly, with the critical orifices in place, the pumps overheated and shutoff. Overheating to the point of shutoff occurred when the pumps were located in a spot without good air circulation. Because the pumps were "over working", they produced more noise which was upsetting to school personnel. Plywood boxes lined with sound absorbing materials and vented in the back were then used to enclose the pumps. This reduced noise levels but compounded the problem of pump overheating and shutoff. Eventually this was resolved



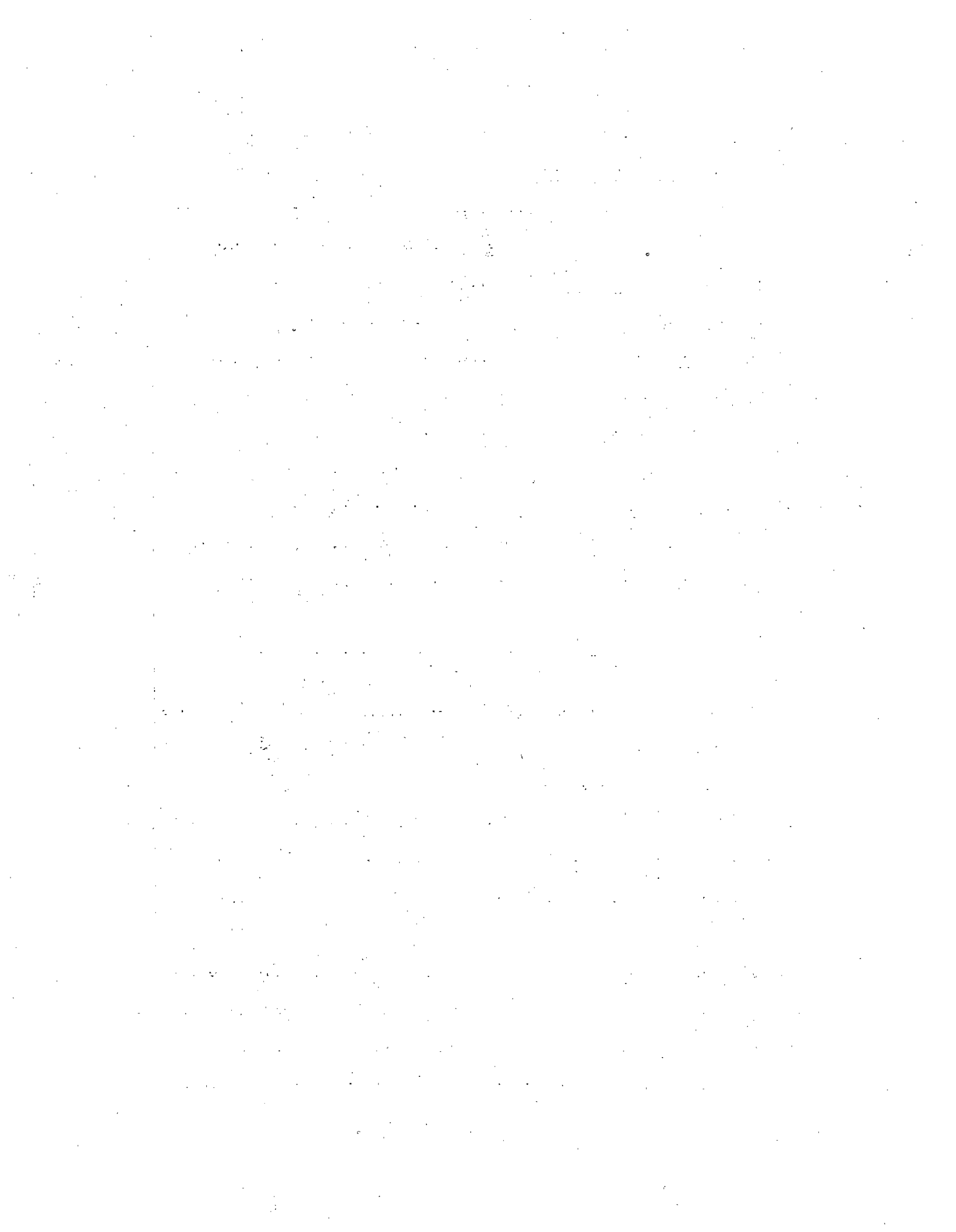
by placing a fan at the head of the box. The third problem was the probable reduction in the life expectancy of the pump mechanism. Overheating caused by the backpressure may have had deleterious effects on machine parts. Consequently, it is recommended that if critical orifices are used that the pump capacity be close to that needed to maintain the proper downstream:upstream pressure ratio. The ratio of 6:1 used in this study caused overheating, shutoff, increased noise, perhaps decrease in pump life, and actually negated the purpose of the critical orifices.

Apart from these two "problems", the directions taken by SAT Program staff proved adequate. The following activities/procedures were undertaken by SAT Program staff, and are strongly recommended for inclusion in a state-wide effort to control asbestos exposure in schools.

Involve Educators, School Maintenance Personnel, Public Health
Officials, and Construction Industry
Personnel in Program Efforts.

Various of these individuals benefit program efforts as legitimizers and promoters. Others, such as contractors and school maintenance personnel require training in safe asbestos treatment procedures. School district superintendents, other district level officials, and public health officials need to be well grounded and versed in the asbestos issue so as to provide appropriate expertise and guidance in the control of asbestos-related problems.

The first contacts made by SAT Program staff were with officials in Colorado's State Department of Education. These individuals were very supportive of the Program and were instrumental in SAT Program staff being able to access school buildings. These individuals also provided information needed to select the "study sample".



Prior to the actual collection of bulk samples in school buildings, district and building officials responsible for these buildings were presented with a one to two hour educational session. These sessions allowed Program staff the opportunity to explain sampling procedures, to overview the "asbestos problem", and to present and discuss safe asbestos treatment procedures. Following these sessions, the task of collecting samples, and reporting results went very smoothly.

Along with the educational sessions provided school officials, Program staff conducted workshops for contractors and school maintenance personnel. In working with and handling asbestos-containing materials, these individuals may unknowingly create asbestos exposure problems. Consequently, these workshops emphasized safe work procedures associated with the encapsulation, enclosure and removal of asbestos-containing materials.

Support Program Efforts with Written Materials. For many individuals the potential health effects of asbestos fiber inhalation is new information. Consequently, written materials serve as important sources of information and guidance. There are a variety of existing publications that may be obtained at no or very low cost. A bibliography is presented in Appendix M. It is also advisable to produce and distribute a list of local agencies and resource people that can assist in the control of asbestos-related problems. Perhaps the single most useful document produced by SAT Program staff was one outlining action steps and resources needed to control asbestos hazards. This document is presented in Appendix F and provides information and directions referencing: groups and organizations capable of conducting asbestos inspections and sampling; laboratories capable of asbestos identification; the selection of

corrective methods; the manufacturers and distributors of respirators, protective clothing, asbestos vacuums, wetting agents, encapsulants, and labels; and asbestos disposal procedures.

Utilize a Low-Keyed, Data Based, Orientation to the Delivery of Program Services. The Potential for asbestos exposure in school buildings can obviously produce an emotional response on the part of parents and other community members. Though SAT Program staff never avoided general public involvement, such involvement was not solicited. The concern of SAT Program staff was that school officials and contractors have the necessary information and training to enable them to proceed in the resolution of asbestos-related problems in an orderly and controlled manner. As witnessed from experiences, primarily occurring in eastern seaboard states, outbreaks of emotionalism may indeed obviate the timely resolution of asbestos-related problems.

Other Recommendations

The following list of activities were not initiated with the SAT Program, but do represent activities other programs/agencies may wish to address.

Define Analysis Methodology for Asbestos Air Samples. There is a need for a defined methodology and laboratory proficiency testing program for environmental asbestos air samples. Although transmission electron microscopy coupled to selected area electron diffraction and energy dispersive X-ray analysis was felt to provide the best information concerning airborne asbestos fibers of all sizes, there are many unresolved problems with the filter preparation technique used in this study and with all filter preparation techniques. Until this methodology has

been worked out, it is recommended that decisions concerning corrective action for asbestos materials not be based on air sampling alone. The procedure of assessing the material condition and potential for fiber release used in this study and recommended by the EPA should be the foundation for decisions. When all laboratories are preparing and analyzing environmental samples by the same electron microscopy technique and cross comparisons of data can be made from one laboratory to another, air sampling results may then prove to have strength in the decision making process.

Create "Bidding Documents" for Use by School Officials. Knowing how to specify asbestos treatment or removal jobs in contracts with construction industry personnel is not within the normal providence of most school officials. Documents, that would at least guide school officials in this process are needed. Such documents would also tend to screen out those contractors unfamiliar with safe asbestos treatment procedures, and thus assure school officials that jobs will done properly.

Throughout the Program, it was a concern of staff members that contractors be identified and trained to properly carry out asbestos treatment jobs. One method of accomplishing this would be to require contractor licensure. However, establishing such licensure is a lengthy and complex process and arming school officials with "bidding documents" would essentially serve the same purpose.

Establish Local "Asbestos Information" Centers. At present, at least in Colorado, there is not a central resource center for the dissemination of asbestos-related information. Though there are several agencies capable of offering advice and assistance, e.g., EPA Region VIII,

Colorado State University, Colorado State Department of Education, Colorado School of Mines, Denver Department of Health and Hospitals, a central clearinghouse has not been established. Reflective of the incomplete information and myths associated with asbestos-related health problems, various of these agencies have pieces and parts of information which may or may not represents "the facts". This situation only tends to exacerbate an already "confused" and "frustrated" general public.

Conduct a Survey to Determine the Costs of Asbestos Treatment or Removal. It has been the experience of SAT Program staff, that among the variables that produce resistance to attacking the asbestos issue in schools, is the notion that this is an extremely expensive task to undertake. By far, the majority of situations encountered by SAT Program staff could be remedied for minimal expense e.g., enclosing an asbestos lined pipe, encapsulating a ceiling, etc. True, the "expense" jobs will need to be done, for example, the removal of sprayed-on material from a gymnasium ceiling, however, these types of jobs are few and far between.

APPENDIX A
PROGRAM PERSONNEL

PROGRAM PERSONNEL

The Program's professional and clerical staff included:

- a) Program Director, Dr. Roy M. Buchan (11% time). Dr. Buchan was ultimately responsible for the completion of all tasks, the expenditure of funds, the direction of program activities, and the supervision of Program staff.
- b) Program Administrator, Dr. Hans H. Johnson (16% time). Dr. Johnson was ultimately responsible for educational input including development of educational materials and methodologies as well as general program planning, coordination, evaluation and delivery of activities.
- c) Industrial Hygienist, Mr. Jeffrey R. Geiger (16% time). Mr. Geiger served as the principal contact with contractors, and primary trainer/speaker/consultant for activities conducted outside of the sample population of schools.
- d) Assistant Professor, Harry J. Beaulieu, (24% time). Dr. Beaulieu coordinated the field sampling, and laboratory analysis and supervised graduate student activities.
- e) Graduate Research Assistant, Cynthia A. Baldwin (70% time). Ms. Baldwin assisted with initial program steps and was responsible for research activities directed toward the prevalence of asbestos-containing materials in Colorado public schools.
- f) Graduate Research Assistant, Donna A. Chadwick (70% time). Ms. Chadwick assisted with initial program steps and responsible for the



research directed toward airborne asbestos concentrations in schools with sprayed-on asbestos-containing materials.

- g) Secretary, Diane K. Hall (34%). Ms. Hall managed the program's files and served as bookkeeper and typist.

APPENDIX B

STRATIFICATION RESULTS OF "STUDY SAMPLE"

AGE OF CONSTRUCTION OF AREAS FROM WHICH
ASBESTOS-CONTAINING SAMPLES WERE OBTAINED

AGE OF CONSTRUCTION	TOTAL
Pre-1946	18
1946-1973	34
Post-1973	4
	—
	56

STRATIFICATION BY GRADE LEVEL

GRADE LEVEL	NUMBER IN STATE	NUMBER SAMPLED
Elementary	733	25 (3.4%)
Junior High	212	7 (3.3%)
Senior High	253	8 (3.2%)
Other	65	1 (1.5%)

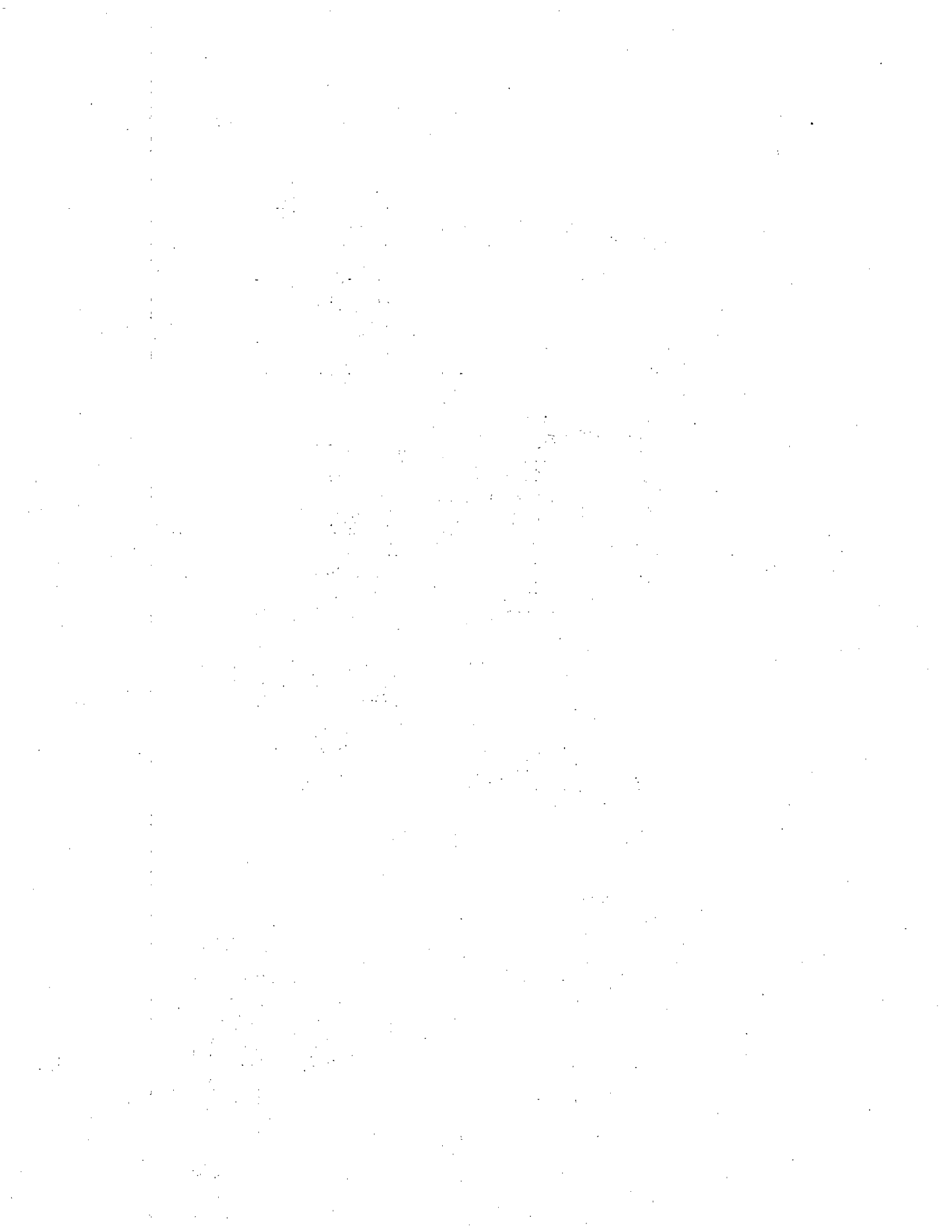


STRATIFICATION OF SCHOOLS BY AGE OF CONSTRUCTION

AGE OF CONSTRUCTION		NUMBER OF SCHOOLS	
Original	Additional*	Statewide	Surveyed
Pre-1946	None	36	5
	Pre-1946	19	2
	1946-1973	72	4
	Post-1973	6	0
	Combination	39	4
1946-1973	None	211	8
	1946-1973	222	4
	Post-1973	60	5
	Combination	59	5
Post-1973		77	4
		<u>801**</u>	<u>41</u>

*Additions and remodelling

**Information available for 801 of 1,263 schools in the state



APPENDIX C

TOPICS COVERED IN TALKS AND SLIDE SHOWS

TOPICS COVERED IN TALKS AND SLIDE SHOWS

BACKGROUND: asbestos as a mineral
 properties of asbestos
 uses of asbestos with emphasis on building construction

HEALTH ASPECTS: diseases of asbestos: asbestosis, bronchogenic carcinoma, mesothelioma ; synergism of smoking and asbestos for bronchogenic carcinoma low level exposures and mesothelioma

SCHOOL EXPOSED POPULATION: children
 teachers
 support staff
 maintenance (repairs, clean-up)

REDUCING EXPOSURES: Proper work practices for maintenance personnel
 identify and label asbestos materials
 respirator and proper clothing for abrasive work and repairs
 wet sweep or vacuum for clean-up
 definition of proper vacuum
 Asbestos in the automechanics shop
 Correcting miscellaneous problems:
 rewinding of pipe lagging
 enclosing accessible pipes
 boiler jackets

Controls for sprayed-on materials:

management
 encapsulation
 enclosure
 removal
 preliminary procedures
 wet removal
 clean up
 disposal
 Role of school in removal procedure: familiarity with procedure at
 check on contractor procedures before and during removal

SAFE ASBESTOS TREATMENT PROGRAM: Objective
 Procedures

APPENDIX D

EDUCATIONAL SESSIONS PRESENTED

EDUCATIONAL SESSIONS PRESENTED

School Districts in the Random Sample:

1. January 8, 1981, Aurora School District, 7 participants.
2. January 12, 1981, Montrose County School District, 10 participants.
3. January 13, 1981, Dolores County School District, 4 participants.
4. January 20, 1981, East Otero School District, 13 participants.
5. March 26, 1981, East Yuma County School District, 4 participants.
6. April 2, 1981, Denver School District, 24 participants.
(Harrison County School District elected not to have an educational session).

Other Schools:

1. October 25, 1980, Boulder Valley School District, Louisville, 10 participants.
2. December 1, 1980, Montezuma-Cortez School District, 8 participants.
3. December 3, 1980, Monte Vista School District, 5 participants.
4. December 5, 1980, Florence School District, 9 participants.

Educational Associations:

1. September 20, 1981, "Solutions to the Asbestos Problem," presented to members of the National Association of State Directors of Educational Plant Services in Denver, Colorado, 20 participants.
2. February 4, 1982, "Practical Approaches to Solving Asbestos Problems," Rocky Mountain Association of School Building Officials, Denver, 40 participants.

Non-School Organizations:

1. October 16, 1980, "Asbestos Removal," Artistic Plumbing, Inc., Denver, 7 participants.
2. March 10, 1981, "Safe Asbestos Treatment," presented to demolition contractors at a seminar ("Asbestos Awareness") sponsored by the Department of Health and Hospitals, Denver, Colorado, 40 participants.
3. April 28, 1981, "Safe Asbestos Treatment," presented at the Colorado Safety Congress, Denver, Colorado, 28 participants.
4. April 29, 1981, "Safe Asbestos Treatment," presented to a private contractor and employees on an asbestos removal job, Leadville, Colorado, 10 participants.



5. May 20, 1981, "Asbestos Identification and Treatment Procedures," Boulder, Colorado, 10 participants.
6. January 22, 1982, "Safe Asbestos Treatment," presented at a meeting of the Asbestos Workers Local #28, 41 participants.

APPENDIX E
CONTENTS OF INFORMATION FOLDER

CONTENTS OF INFORMATION FOLDER

Health Hazards of Asbestos, Cancer Alert Series, U.S. Department of Labor, Occupational Safety and Health Administration, 1979, U.S. Government Printing Office, Washington, D.C., 0-632-523/167.

Asbestos Exposure: What It Means: What To Do, U.S. Department of Health, Education, and Welfare, Public Health Services National Institutes of Health, Washington, D.C., 1978, DHEW(NIH) 78-1594.

Asbestos Exposure: A Desk Reference for Communicators, U.S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, Washington, D.C., 1978, DHEW(NIH) 78-1622.

Publications on Toxic Substances: A Descriptive Listing, Interagency Regulatory Liaison Group, 1979, U.S. Government Printing Office, Washington, D.C., 052-011-00226-7.



APPENDIX F

"ASBESTOS: THE PROBLEM"

AND

"ASBESTOS: CONTROL OF ASBESTOS HAZARDS - ACTIONS, STEPS AND RESOURCES"

EDUCATION
RESEARCH
SERVICE

INFORMATION SERIES

ASBESTOS :
The Problem

OCCUPATIONAL HEALTH AND SAFETY SECTION
INSTITUTE OF RURAL ENVIRONMENTAL HEALTH
110 VETERINARY SCIENCE BUILDING
COLORADO STATE UNIVERSITY
FORT COLLINS, COLORADO 80523
303/491-6151

INTRODUCTION

Warnings were issued as early as 1971 that asbestos might pose a serious environmental health hazard in school buildings across the nation. However, little was done to deal with the problem on a national level until 1977, when reports of asbestos exposure in New Jersey schools were widely published.

Recent estimates suggest that an asbestos hazard may exist in as many as 10,000 public schools in the United States. This astonishing and worrisome situation exists chiefly because asbestos was used extensively in school building construction between 1946 and 1973 as a component of fireproofing, insulation, and acoustical materials.

Asbestos fibers are released from indoor materials such as ceiling and wall coatings through fallout and contact. Fallout of fibers comes from the aging and degradation of the bonding material in an asbestos-containing product. It is usually low level, continuous, and may increase with the age of the building.

Contact with asbestos-containing material, especially sprayed asbestos coatings, can easily result in the release of asbestos fibers. This is particularly true in school buildings, which tend to be subjected to extra wear and tear because of various student activities.

When fallen debris and dust containing asbestos particles are swept up by school maintenance workers, large amounts of respirable asbestos fibers can be resuspended in the air. Normal hustle and bustle by school children can have the same result. Once asbestos fibers become airborne in an indoor environment, they tend to stay aloft for long periods of time. In fact, some fibers can remain in the air—and, therefore, in the breathing zone of a person—for up to 80 hours.

In 1972, the National Cancer Institute reported that 12 cases of malignant mesothelioma had occurred in the United States between 1960 and 1968 in people under the age of 20. A recent case of mesothelioma in a school maintenance worker in Massachusetts has increased the suspicion among some researchers that asbestos pollutions in the nation's schools may already be causing disease.

During the past couple of years, school officials and others have expressed great concern over the possibility that children, teachers and maintenance workers are being exposed on a regular basis to hazardous concentrations of asbestos. In Massachusetts, a special commission was created to investigate the asbestos hazard in schools. It found asbestos in student areas in 138 out of 1,200 schools that were surveyed. Widespread use of asbestos in schools has been reported in Indiana, Kentucky, and other states. If the estimates from the states already surveyed are applied to the entire nation, between 2 and 6 million students may be attending schools with asbestos surfaces in pupil areas. An additional 200,000 to 300,000 teachers could also be exposed.

This pamphlet is intended to provide school officials and other school employees information about the nature of the asbestos hazard and what is known about asbestos related disease.

THE FACTS

1. Asbestos is a naturally occurring, virtually indestructible mineral mined from rock and made up of countless easily inhaled, twine-like fibers. The fibers are soft, but they resist heat and chemicals, and they match piano wire in strength. Asbestos fibers are extremely small. The ones you can see with an ordinary microscope are made up of even tinier fibers. If you put a million of them side by side, they'd take up just one inch. It is the small size and indestructibility of asbestos fibers that makes them so dangerous to human health.
2. The first use of asbestos was recorded about 2,000 years ago. It was a "magic mineral" used by the early Greeks for wicks in their candles. The following is a brief history of asbestos use in the U.S. and its toxic effects:
 - 1880 - Asbestos introduced to U.S. Industry
 - 1900 - First medically diagnosed death from asbestos in England.
 - 1918 - American and Canadian insurance companies stopped insuring asbestos workers.
 - 1930 - Relationship between asbestos exposure and asbestosis was confirmed.
 - 1935 - U.S. and England research indicated a link between asbestos exposure and lung cancer.
 - 1955 - The association between asbestos and cancer was confirmed.
 - 1960 - U.S. and England research indicated a link between low level asbestos exposure and mesothelioma.
 - 1973 - The Environmental Protection Agency banned the spray-on application of asbestos.
 - 1976 - Current worker asbestos exposure standard set by the Occupational Safety and Health Administration.
3. Most of the asbestos used in the United States is mined in Canada. According to U.S. Bureau of Mines reports, more than 700,000 tons of asbestos are used annually in the United States. Further, the list of products containing asbestos is long and reaches into the lives of nearly everyone. Asbestos is found in more than 3,000 products.
4. More than 77 percent of mined asbestos is used by the construction industry for building insulation, floor and ceiling tiles, covering for pipes, cables and electric wires, fire and heat shields, fire-resistant curtains, roofing shingles and coatings, insulation for ships, and in cement mixtures.
5. Asbestos is used in brake linings for automobiles, railroad cars and airplanes. As many as 158,000 pounds of asbestos are released into the air each year from auto brake linings alone.

ASBESTOS PRODUCTS

<u>Floor Tile</u>	<u>Gaskets and Packings</u>	<u>Friction Products</u>
Office floors Commercial floors Residence floors	Valve components Flange components Pump components Tank sealing components	Clutch/transmission components Brake components Industrial friction materials
<u>Paints, Coatings and Sealants</u>	<u>Asbestos-Reinforced Plastics</u>	<u>Asbestos Cement Pipe</u>
Automotive/Truck body coatings Roof coatings and patching compounds	Electric motor components Molded product compounds for high-strength/weight uses	Chemical process piping Water supply piping Conduits for electric wires
<u>Asbestos Textiles</u>		<u>Asbestos Cement Sheet</u>
Packing components Gasket components Roofing materials Commercial/industrial dryer felts Heat/fire protective clothing Clutch/transmission components Electrical wire and pipe insulation Theater curtains and fireproof draperies		Hoods, vents for corrosive chemicals Chemical tanks and vessel manufacturing Portable construction buildings Electrical switchboards and components Residential building materials Molten metal handling equipment Industrial building materials Fire protection Insulation products Small appliance components Electric motor components Laboratory furniture Cooling tower components
<u>Asbestos Paper</u>		
Gas vapor ducts for corrosive compounds Fireproof absorbent papers Table pads and heat protective mats Heat/fire protection components Molten glass handling equipment Insulation products Gasket components Underlayment for sheet flooring Electric wire insulation Filters for beverages Appliance insulation Roofing materials		

6. Between 1946 and 1973 asbestos was often used to fireproof and insulate schools. The Environmental Protection Agency estimates that more than 10,000 (10-15 percent) of the schools in the United States contain asbestos. EPA's voluntary inspection and control plan, instituted in March 1979, has not been sufficiently effective. Only about 60 percent of the nation's schools have taken steps to identify asbestos problems under this program. Proposed EPA regulations (Federal Register, September 17, 1980, pp. 61966-97) would require schools to be inspected for asbestos problems. EPA is coordinating its proposal with rules being issued by the Department of Education under the 1980 School Asbestos Act (Federal Register, September 17, 1980, pp. 61950-64). The Education Department proposal established a grant and loan program to assist local education departments by funding up to 50 percent of the cost of asbestos identification and control.
7. Because asbestos fibers are so small and fine, when breathed in, they are not readily trapped by mucus or nose hairs, and therefore can easily enter the lungs. Once in the lungs, asbestos fibers may lodge there and remain for life. Once lodged in the lungs, asbestos fibers may cause lung cancer, mesothelioma (a rare cancer of the linings of the chest or abdomen) and asbestosis, an incurable and debilitating (but non-cancerous) lung disease. Asbestos fibers can also be swallowed and may possibly cause cancer of the stomach, colon and rectum. A government study predicts that as many as 20,000 asbestos-related deaths will soon occur each year and that about 15 percent of all American cancer cases will be directly linked to asbestos exposure.

PLAIN TALK

1. Are all types of asbestos harmful?

Yes. Every type of asbestos can cause asbestosis and/or cancer. There are six major types of asbestos: anthophyllite, amosite, tremolite, actinolite, crocidolite, and chrysotile. Each type can cause asbestosis and each type can cause cancer. There is no safe type of asbestos, however, recent studies suggest that some types are "safer" than others.

2. How does asbestos cause disease?

The answer to this question is not fully understood by medical scientists. This much is known: when disturbed, countless numbers of invisible asbestos fibers can become airborne in the manner of house dust. Because of their tiny size, these needle-like fibers are easily inhaled and swallowed. Although many asbestos particles are eliminated from the body through natural processes, many others find their way into the lungs and respiratory tract. Here they can become lodged in delicate tissues, causing lesions that eventually result in disease.

Because of its remarkable durability, asbestos can remain in the lungs and other tissues for a lifetime. Moreover, since asbestos fibers can be transported by the blood stream and the lymphatic system, they can migrate from the lungs, causing disease in other parts of the body.

People do not become sick immediately after inhaling asbestos. The delay from the time of first exposure to the time asbestos disease develops is known as the latent period. For most asbestos disease, this latent period is anywhere from 15 to 35 or more years.

3. What kinds of disease are caused by asbestos?

Heavy exposure to asbestos can cause asbestosis, and greatly increases the risk of lung cancer and cancer of the gastrointestinal tract. Even lighter exposures to asbestos can result in mesothelioma, a cancer of the membranes that encase the lungs and line the abdominal cavity.

- **ASBESTOSIS.** Asbestosis is an incurable, untreatable scarring of the lungs caused by asbestos fibers lodging in the lungs. In an attempt to rid itself of these fibers, the body forms a shell of scar tissue around them. As the scar tissue spreads, pulling the lungs out of shape, the amount of oxygen transferred to the bloodstream is reduced. Asbestosis normally takes 20-30 years after exposure to develop, with no warning symptoms in the earlier stages. The most obvious symptoms a person with asbestosis will notice is shortness of breath. Activities that were always routine

or simple to accomplish, such as climbing stairs, lifting, washing the car, etc., will cause severe shortness of breath and become extremely difficult to perform without intermittent rest. Also, many victims will develop a pain in the back or chest and experience weight loss. No cure is known for asbestosis.

- **LUNG CANCER AND GASTROINTESTINAL CANCER.** Lung cancer is by far the most common cause of death among asbestos workers today, particularly among those who smoke cigarettes. Between 20 and 25 percent of all deaths in some groups of heavily exposed workers are due to lung cancer. By comparison, about 4 to 5 percent of all deaths in the general population are caused by lung cancer. No one knows how much asbestos exposure is necessary to cause lung cancer and gastrointestinal cancer. However, a study of 250 asbestos workers who were heavily exposed to asbestos dust for periods of only three months or less shows that 25 years later they died of lung cancer at 3.5 times the expected rate. Some investigators consider it possible that a worker who was heavily exposed to asbestos for just one day could develop cancer years later as a result.
- **MESOTHELIOMA.** This type of cancer attacks the pleura, which is the delicate membrane that encases the lungs. It also attacks the peritoneum, a similar membrane that lines the abdominal cavity. Twenty-five years ago, mesothelioma was so rare it was considered to be a pathological curiosity. Today, more than 5 percent of all asbestos workers die of this disease. Mesothelioma takes from 20 to 50 years to develop. Remarkably, mesothelioma almost never occurs without some, even a slight, history of exposure to asbestos. Further, it is now being found increasingly in people whose only known exposure to asbestos was that they lived in the vicinity of factories where asbestos products were manufactured, or lived in the same house as workers who came home with asbestos dust on their clothes. Mesothelioma is almost always malignant, and, when malignant, is invariably fatal.

4. Will all persons exposed to asbestos eventually get cancer?

No. It is still unknown why different toxic materials affect people differently. In the case of asbestos exposure, persons may be working side by side with close to identical exposure. Some will become diseased and some will not. Lung cancer, mesothelioma and cancers of the stomach, colon and rectum are caused by asbestos exposure. Scientists do not understand why asbestos causes cancer. One explanation is that asbestos fibers absorb or hold other cancer-causing chemicals in close contact with body cells. It has been shown that a person heavily exposed to asbestos has a 30-90 times higher risk of developing lung cancer if that person also smokes.

5. Are short term exposures to asbestos risky?

Yes. Until adequate studies are performed to establish safe exposure levels, any exposure to asbestos should be considered risky. Low levels of asbestos or short-term exposures (for example, just one day working with asbestos) increases the risk of cancer and asbestosis.



One study found that about 12 percent of workers in an asbestos factory, exposed to asbestos for less than one month, died from asbestos-related diseases 5-35 years later.

6. Who is exposed to asbestos?

Currently, asbestos provides jobs for 90,000 American workers. It is found in virtually every workplace, and products containing asbestos are common in homes, automobiles, schools, churches — everywhere. Indirectly, everyone faces the possibility of being exposed to asbestos.

A very conservative estimate is that 11 million workers have been exposed to asbestos since the start of World War II — nearly half of them in shipyards. Of the 4 million workers who have been heavily exposed, more than a third are expected to die of cancer. The death toll among U.S. workers exposed to asbestos will probably average 67,000 a year.

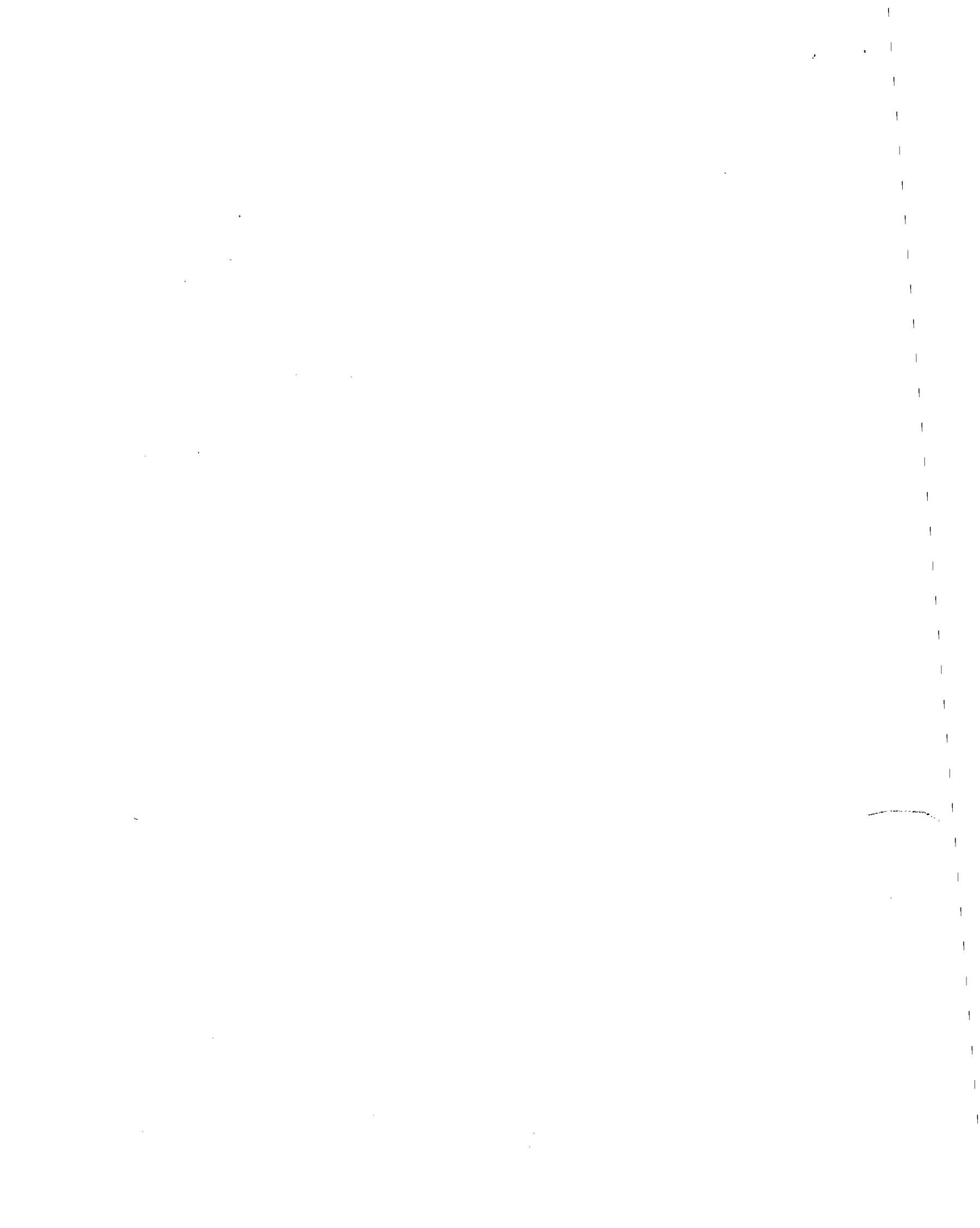
There is disturbing evidence, however, that the hazards of asbestos reach beyond the workplace and endanger communities and families. Unsuspecting passersby in the vicinity of construction or demolition sites are also exposed to the asbestos dust released in these operations. The general public is also exposed to measurable levels of asbestos in schools, churches, office buildings, libraries, and other public buildings in which asbestos was used in insulating, fireproofing, or in the many other popular applications. Clearly, asbestos could have a significant effect on community health due to its widespread use and toxicity. However, to date there have been no comprehensive health studies of the effects of asbestos pollution on a community. Further, workers seldom realized that toxic materials used in the workplace can be carried home. Numerous cases of mesothelioma have been reported among people who live in the same house with asbestos workers. Asbestos is brought home by workers on their clothing, shoes, lunch boxes, tool boxes, body hair, and in the interior of the family car.

EDUCATION
RESEARCH
SERVICE

INFORMATION SERIES

ASBESTOS:
Control of Asbestos Hazards:
Actions, Steps and Resources

OCCUPATIONAL HEALTH AND SAFETY SECTION
INSTITUTE OF RURAL ENVIRONMENTAL HEALTH
110 VETERINARY SCIENCE BUILDING
COLORADO STATE UNIVERSITY
FORT COLLINS, COLORADO 80523
303/491-6151



INTRODUCTION

Contamination of school buildings from asbestos-containing materials can occur not only during construction and demolition, but also through normal building wear and tear and maintenance. Considering the large number of pupils, teachers, and other school employees that may be exposed, every effort to reduce exposure levels to as low as possible is essential. It is the purpose of this pamphlet to outline the various methods of asbestos exposure control available to school officials and other school decision makers. Further this pamphlet presents several lists which should be helpful to school officials in obtaining additional information, professional services, and asbestos control equipment. The control of asbestos exposure in school buildings may be achieved through the application of (1) physical controls and (2) through the education of persons whose responsibility it is to complement and carry out asbestos-control measures.

CONTROL OF ASBESTOS HAZARDS:

ACTION STEPS AND RESOURCES

INSPECTION AND SAMPLING

•See Appendix A:

Groups and Organizations Capable of Conducting Asbestos Inspections and Sampling

•See Appendix B:

Laboratories Capable of Asbestos Identification

Asbestos-containing material is commonly found in spray-on form, on steel support beams and columns, and on ceilings and walls of classrooms, corridors, auditoriums, cafeterias, and gymnasiums. Other common asbestos-containing materials include pipe wrappings, ceiling tiles and boiler insulation.

When the inspection and sampling process is conducted by school personnel, the following procedures are recommended:

- (1) Use a small container such as a plastic 35 mm film canister or a small, wide-mouthed glass jar with a screw-on lid. The container should be dry and clean.
- (2) Gently twist the open end of the container into the material. A core of the material should fall into the container. A sample can also be taken by using a knife to cut out or scrape off a small piece of material and then placing it into the container.

Be sure to penetrate any paint or protective coating and all the layers of the material. If the sample container cannot penetrate the material, consider whether the material is really friable or not.

- (3) Tightly close the sample container; wipe the exterior of the container with a damp cloth to remove any material which may have adhered to it during sampling.
- (4) Tape the container lid to prevent the accidental opening of the container during shipment or handling.
- (5) Label the sample container. This label should identify the school and date the sample was taken, and bear a unique identification (ID) number.

- (6) Make a record of each sample by noting the date the sample was taken, location of material sampled, the area or room sampled, and the sample ID number.
- (7) Send the sample to an analytical laboratory for analysis.

EXPOSURE ASSESSMENT

- See Appendix C:

*An Aid in
Evaluating
Potential Asbestos
Exposure*

If laboratory analysis establishes that asbestos is present in a sample, the potential exposure of students and other building users should be evaluated. Factors such as the condition of the material sampled, characteristics of the building, and human activity have significance in any potential exposure situation. Appendix C provides an easy scoring system which can be used as an aid in assessing the potential of asbestos exposure.

CORRECTIVE ACTION

- See Appendix D:

*Selection of a
Corrective
Action Method*

If friable asbestos material is present and exposure is occurring or will likely occur, corrective action should be considered. The selection of the method or methods of action should reach the most efficient long-term solution after consideration of material condition, location, function, and cost.

There are four approaches to controlling exposure:

- See Appendix E:

*A Comparison of
Asbestos
Replacement
Products*

- (1) Removal: Asbestos material is removed and disposed of by burial.
- (2) Encapsulation: Asbestos material is coated with a bonding agent called a sealant.
- (3) Enclosure: Asbestos material is separated from the building environment by barriers such as suspended ceilings.
- (4) Deferred action: No action is taken. The area is inspected periodically for changes in exposure potential.

- See Appendix F:

*Distributors of
Asbestos-Free
Products*

- See Appendix G:

*Obtaining Product
Information—
The Material
Safety Data
Sheet*

Removal, encapsulation, and enclosure are corrective methods and can be used separately or in combination. Removal completely eliminates the source of exposure to asbestos and is, therefore, a permanent solution. Both enclosure and encapsulation are containment methods.

PERSONAL PROTECTIVE EQUIPMENT

When school maintenance personnel do re-fitting work on boilers, or are in other ways required to disturb asbestos-containing material, it is necessary to provide them appropriate respirators and protective clothing.

- See Appendix H:

*Respirators—
Names and
Addresses of
Manufacturers
and Distributors*

- See Appendix I:

*Respirator Limits
for Asbestos
Exposure*

- See Appendix J:

*Manufacturers
and Distributors
of Protective
Clothing*

Wearing a respirator is frequently the only feasible method of controlling asbestos exposure. The type of respirator needed—for example, air-purifying or supplied-air—depends on the asbestos level in the work environment (see Appendix I). For most repair and maintenance jobs in school, the air-purifying type of respirator will be sufficient; however, it is good practice to discuss the nature of specific jobs with distributors or other professionals when purchasing respirators.

The use of respirators should not be taken lightly. Since the devices place a burden on the respiration of the wearer—and, at best, are a nuisance—a determination must be made as to whether an individual can use the equipment and perform whatever work it is that he is assigned to do. Factors that must be considered in such a determination include: physiologic/physical ones such as oxygen needs for the task, hair, beards, and glasses; medical conditions that may be present such as pulmonary or cardiovascular disease; and psychological disposition toward wearing a respirator.

It is also advisable to provide maintenance personnel with protective clothing, such as coveralls or other full body clothing, head coverings, gloves, and foot coverings, when they are required to disturb asbestos-containing material. If precautions are not taken with clothing the potential for bringing asbestos fibers home and thus exposing family members exists. Disposable protective clothing is preferred. When contaminated clothing needs laundering, it must be placed in a sealed container and labelled so as to protect others from exposure. If washed at home, run washer empty to flush out fibers.

WORK PRACTICES

- See Appendix K:

*Manufacturers
and Distributors
of Asbestos
Vacuums*

- See Appendix L:

*Manufacturers
and Distributors
of Wetting Agents
for Wet Removal
of Asbestos*

Cleaning operations are part of the normal work routine, but procedures which will minimize dust are best. Asbestos dust must not accumulate on work surfaces or tools. In cleaning operations which may release asbestos into the air, "wet" methods should be used wherever possible.

Workers should avoid blowing, dry brushing, or dry mopping since these methods will spread asbestos around the workplace. Vacuum cleaners or wet wiping cloths will clear surfaces without raising dust.

Anything taken into the workplace, such as food, beverages, cigarettes, or personal belongings will also pick up particles. All these materials must be stored away from areas where asbestos is used.

Eating, drinking, or smoking should never be allowed where asbestos is present, since any of these activities could allow the asbestos particles to be taken directly into the body.

DISPOSAL OF
ASBESTOS WASTE
MATERIAL

- See Appendix M:

*Policy
Statement for
Asbestos Wastes—
Colorado
Department of
Health*

Properly sealed containers are the place for disposing of asbestos waste, scrap, debris, or contaminated clothing which might produce airborne concentrations of asbestos. Waste materials should be packed into labeled 6-mil plastic bags held within 55-gal drums. Packed and sealed drums, with proper labeling, should be delivered to predesignated disposal sites for burial.

- See Appendix N:

*Manufacturers
and Distributors
of Labels for
Asbestos Waste
Materials*

EDUCATION

- See Appendix O:

*Sources of
Information—
Organizations and
Publications*

Implicit in the effort to control student and school employee exposure to asbestos are several goals of education—increased knowledge of:

- (1) The nature of asbestos and diseases that may result from exposure to asbestos fibers and how these diseases are manifested.
- (2) Appropriate work practices associated with the removal, encapsulation or enclosure of asbestos-containing materials.
- (3) The methods and procedures of asbestos identification and hazard assessment.
- (4) Appropriate personal protective devices and clothing which are necessary when working with asbestos.
- (5) Available resources—persons, organizations, publications, manufacturers, distributors, etc.

APPENDIX A

Groups and Organizations Capable of Conducting Asbestos Inspections and Sampling

Occupational Health and Safety Section
Institute of Rural Environmental Health
110 Veterinary Science Building
Colorado State Universtiy
Fort Collins, Colorado 80523
(303)491-6151

Hager Laboratories
12000 East 47th Avenue
Denver, Colorado 80239
(303)371-1441

Colorado School of Mines
Research Institute
Post Office Box 112
Golden, Colorado 80401
(303)279-2581

Petrography Consultant
31720 Hilltop Road
Golden, Colorado 80401
(303)642-7559

National Institute of Occupational Health
and Safety
DHHS Region VIII
11037 Federal Building
Denver, Colorado 80294
(303)837-3979

Environmental Protection Agency
Region VIII
1860 Lincoln Street
Denver, Colorado 80295
(303)837-5927

APPENDIX B

Laboratories Capable of Asbestos Identification

Nearby

Hager Laboratories
12000 East 47th Avenue
Denver, Colorado 80239
303/371-1441

Petrography Consultant
31720 Hilltop Road
Golden, Colorado 80401
303/642-7559

Colorado School of Mines
Research Institute
Post Office Box 112
Golden, Colorado 80401
303/279-2581

Utah Biomedical Test Laboratory
520 Wakara Way
Salt Lake City, Utah 84108
800/453-5653

Other

United States Testing Company,
Incorporated
1415 Park Avenue
Hoboken, New Jersey 07030
201/792-2400

EMV Associates, Incorporated
Microanalysis Laboratory
15825 Shady Grove Road
Rockville, Maryland 20850
301/948-7400

Walter McCrone Associates, Inc.
2820 South Michigan Avenue
Chicago, Illinois 60616
312/842-7100

Environment/One Corporation
2773 Balltown Road
Schenectady, New York 12301
518/346-6161

Wausau Insurance Companies
Environmental Health Laboratory
2000 Westwood Drive
Wausau, Wisconsin 54401
715/845-5211

Environmental Consulting & Testing
Services
Post Office Box 3521
Cherry Hill, New Jersey 08034
609/779-1195

Health Science Associates
Suite B/C
10941 Bloomfield Street
Los Alamitos, California 90720
213/430-1031

Environmental Health Services, Inc.
5206 Lindbergh Boulevard
West Carrollton, Ohio 45449
513/293-0025

Herron Testing Laboratories
5405 Schaaf Road
Cleveland, Ohio 44131
216/524-1450

Erie Testing Laboratories
2401 West 26th Street
Erie, Pennsylvania 16506
814/833-4790

IIT Research Institute
10 West 35th Street
Chicago, Illinois 60616
312/567-4303

Erlin, Hime Associates
811 Skokie Boulevard
Northbrook, Illinois 60062
312/272-7730

GCA Corporation
Technology Division
Burlington Road
Bedford, Massachusetts 01730
617/275-9000

Geoscience Consultants, Inc.
Post Office Box 341366
Coral Gables, Florida 33134
305/446-5801

Interscience Research
2614 Wyoming Avenue
Norfolk, Virginia 23513
804/853-8813

Jesse H. Bidanset & Associates,
Incorporated
Post Office Drawer "0"
609 Middle Neck Road
Great Neck, New York 11023
516/829-8763

Law Engineering Testing Company
3301 Winton Road
Raleigh, North Carolina 27619
919/876-0416

LFE Corporation
Environmental Analysis Lab
Division
2030 Wright Avenue
Richmond, California 94804
415/235-2633

Maryland Mineral Analysis
Laboratory
Department of Geology
University of Maryland
College Park, Maryland 20740
301/454-3548

MJH Associates
Mineralogical Consultants
13345 Foliage Avenue
Apple Valley, Minnesota 55124
612/432-8836

Northrop Services, Incorporated
Post Office Box 12313
Research Triangle Park,
North Carolina 27709
919/549-0611

PEDCo Environmental, Incorporated
11499 Chester Road
Cincinnati, Ohio 45246
513/782-4700

Fay Goldblatt
407 North Butrick Street
Waukegan, Illinois 60085
312/249-1745

American Can Company
Safety and Industrial Hygiene
Laboratory
U.S. Highway 22
Union, New Jersey 07083
201/686-4500

American Microscopy Laboratory
D. 3410 12th Avenue E
Tuscaloosa, Alabama 35405
205/349-2852

Analytical Center, Inc.
Post Office Box 15635
Houston, Texas 77020
713/676-0141

Boeing Technology Services
9R-25
Post Office Box 3707
Seattle, Washington 98124
206/237-2722

Brewer Analytical Laboratories
311 Pacific Street
Honolulu, Hawaii 96810
808/533-4411

C.E.D., Incorporated
Environmental Microscopy International
135 West Cutting Boulevard
Richmond, California 94804
415/234-3761

Casalina Associates, Incorporated
47-345 Mahakea Road
Kaneohe, Hawaii 96744
808/239-6514

Princeton Testing Laboratory
Post Office Box 3108
Princeton, New Jersey 08540
609/452-9050

Southwestern Laboratories
Post Office Box 10687
Dallas, Texas 75207
214/688-0088

Saint Paul Fire & Marine
Environmental Services Analytical
Laboratory
494 Metro Square Building
Seventh and Robert Streets
Minneapolis, Minnesota 55440
612/221-7043

Sunbelt Associates, Incorporated
6961 Mayo Road
New Orleans, Louisiana 70126
504/242-5026

Thomas A. Kubic & Associates
8 Pine Hill Court
Northport, New York 11768
516/261-2117

Tri-State Laboratories, Inc.
54 Westchester Drive
Austintown, Ohio 44515
216/793-8800

Truesdail Laboratories, Inc.
4101 North Figueroa Street
Los Angeles, California 90065
213/225-1564

Industrial Analytical Laboratory
1523 Kalakaua Avenue
Suite 101
Honolulu, Hawaii 96826
808/949-6191

Industrial Hygienics, Inc.
755 New York Avenue
Huntington, New York 11743
516/427-0950

Industrial Testing Laboratories,
Incorporated
2350 Seventh Boulevard
Saint Louis, Missouri 63104
314/771-7111

Inter-City Testing & Consulting
Corporation
Post Office Drawer "0"
609 Middle Neck Road
Great Neck, New York 11023
516/829-8762

Certified Testing Laboratories, Inc.
2905 East Century Boulevard
South Gate, California 90280
213/564-2641

Clayton Environmental Consultants,
Incorporated
25711 Southfield Road
Southfield, Michigan 48075
313/424-8860

Continental Insurance Companies
Environmental Health Laboratory
1810 Commerce Street
Dallas, Texas 75201
214/748-7351

Department of Geological Sciences
SUNY, New Paltz
New Paltz, New York 12562
914/257-2166

Department of Geology
Illinois State University
Normal, Illinois 61761
309/436-8922

Eastern Analytical Laboratories
One "A" Street
Burlington, Massachusetts 01803
617/272-5212

EMS Laboratories
12517 Crenshaw Boulevard
Hawthorne, California 90250
213/973-6694

APPENDIX C

An Evaluation Aid in Assessing Potential Asbestos Exposure

NOTE OF CAUTION: This evaluation aid is presented to provide general guidance. If there is any question as to the potential for asbestos exposure to students and other building users, professional consultation is necessary.

Directions for use

1. For each of the 6 factors, circle the most appropriate numerical value (circle only one number per factor)
2. Add up all of the circled numbers, and refer to the "Action Suggestions."

Note: The minimum total value is 6, and the maximum total value is 18.

ACTIVITY The potential, because of room use, for damage to asbestos containing material.

<u>Numerical Value</u>	<u>Evaluation Category</u>
1	Low activity areas. (e.g., closets and storage rooms; conference room; faculty room; administration offices; nurse's office; janitor's room; boiler room)
2	Moderate activity areas. (e.g., locker room; music room; cooking, sewing and typing rooms; science room; shops; general classrooms; kitchen)
3	High activity areas. (e.g., gymnasium; auditorium; cafeteria; hallways and stairwells; swimming pool; all purpose rooms)

ACCESSIBILITY The relative ease with which the asbestos - containing material may be reached or disturbed.

Numerical Value

Evaluation Category

- | | |
|---|---|
| 1 | Totally enclosed/encapsulated or tightly bound. (e.g., pipe lagging behind enclosed radiators; floor tiles unless scored or sanded) |
| 2 | Generally inaccessible to school population. (e.g., ceiling tiles and spray-on beyond normal hand reach or potential damage from thrown objects; pipe lagging in locked closet) |
| 3 | Accessible. (e.g., pipe lagging, ceiling, etc., within hand reach or subject to damage from thrown objects—gymnasium, hallway, classroom ceilings) |

CONDITION The degree of deterioration and damage of asbestos-containing material.

Numerical Value

Evaluation Category

- | | |
|---|---|
| 1 | No damage at all. |
| 2 | Slight to moderate damage. (e.g., small chips missing from ceiling tiles; mild water stains on ceilings; loose pipe wrapping) |
| 3 | Severe damage. (e.g., scored or punctured pipe lagging, loosely hanging material, severe water damage, etc.) |

FRIABILITY The ease with which the asbestos-containing material may be broken apart.

<u>Numerical Value</u>	<u>Evaluation Category</u>
1	Nonfriable. (i.e., potential asbestos firmly bound such as in some floor tiles and pipes; material cannot be broken or fractured with hands)
2	Moderately friable. (i.e., material may be broken or fractured with hands, but breaks up in relatively large pieces)
3	Very friable. (i.e., material is easily broken apart with hands and easily crumpled with fingers)

AIR MOVEMENT The degree to which asbestos fibers may accumulate at sample site.

<u>Numerical Value</u>	<u>Evaluation Category</u>
1	Presence of mechanical air moving system which exhausts air to building exterior
2	Limited air movement (i.e., open doors and windows, ceiling fan, etc.)
3	Essentially no air movement

PERCENT ASBESTOS The amount of asbestos contained in the material.
 (NOTE: This will be indicated on the laboratory analysis report.)

<u>Numerical Value</u>	<u>Evaluation Category</u>
1	One to 10 percent
2	Eleven to 25 percent
3	Twenty-six to 50 percent
4	Fifty-one percent or more



Numerical Value Total
 (Add up circled numbers)

Action Suggestions		
	If total value equals	
Defer Action	6-8	If it is determined that the exposure is negligible or that there is no potential exposure, action can be deferred. However, a continuing inspection program is necessary to ensure that if the situation changes, steps will be taken to control exposure.
Corrective Action	9-18	This may include removal, encapsulation, or enclosure. A professional should be consulted in making this decision.

APPENDIX D

Selection of a Corrective Action Method

Method	Advantages	Disadvantages	Consider when	Do not consider when
• Removal	<ul style="list-style-type: none"> • Eliminates asbestos source • Ends exposure 	<ul style="list-style-type: none"> • Usually most costly and complicated method • Usually most time consuming method • Replacement with substitute material may be necessary • Higher potential for worker exposure 	<ul style="list-style-type: none"> • High exposure • Material is deteriorating or damaged • Material is accessible • Flat, open material surface 	<ul style="list-style-type: none"> • Removal is not feasible because of cost, location of material, and kind of surface to which material has been applied (e.g., removal of material from complex surfaces such as pipes, lines, and ducts)
• Encapsulation	<ul style="list-style-type: none"> • Controls exposure • Usually most rapid and economical method 	<ul style="list-style-type: none"> • Asbestos source remains • If material is damaged or deteriorating, additional weight of the sealant may cause delamination • Management system required. Precautions necessary to prevent damage during maintenance or renovation 	<ul style="list-style-type: none"> • Removal not feasible • Material still retains bonding integrity • Damage to material not probable • Limited accessibility of material 	<ul style="list-style-type: none"> • Removal feasible • Material does not adhere well to substrate. Weight of sealant may cause delamination • Material is deteriorating or damaged • Damage to material is probable

Method	Advantages	Disadvantages	Consider when	Do not consider when
		<ul style="list-style-type: none"> • Continuing inspection required to check for damage to encapsulated surface • Maintenance on damaged or deteriorating encapsulated surface required • Encapsulated material is difficult to remove 	<ul style="list-style-type: none"> • Complex surfaces to be covered • Economic or time advantage 	<ul style="list-style-type: none"> • Water damage • Continuing inspection and maintenance of encapsulated material doubtful
• Enclosure	<ul style="list-style-type: none"> • Controls exposure • May be most rapid, economical, uncomplimented 	<ul style="list-style-type: none"> • Asbestos source remains • Fiber fallout continues behind enclosure • May be costly if enclosure disturbs functions of other systems (e.g., enclosure may require lighting changes) • Management system required. Precautions necessary for entry into enclosure for maintenance or renovation • Continuing inspection required to check for damage to enclosure system 	<ul style="list-style-type: none"> • Removal not feasible • Disturbance or entry into enclosed area not likely • Economic advantage 	<ul style="list-style-type: none"> • Removal feasible • Damaged or deteriorating material causing high levels of fiber fallout • Water damage • Damage to enclosure likely • Entry into enclosure probable for repairs and maintenance • Continuing inspection and maintenance of enclosure doubtful

Method	Advantages	Disadvantages	Consider when	Do not consider when
•Deferred Action	•No direct cost	<ul style="list-style-type: none"> •Maintenance on damaged enclosure system required •Potential for exposure may increase •Management system required. Precautions necessary to prevent damage during maintenance or renovation 	<ul style="list-style-type: none"> •Negligible exposure potential 	<ul style="list-style-type: none"> •Definite or questionable exposure potential •Continuing inspection doubtful
		<ul style="list-style-type: none"> •Continuing inspection and reevaluation necessary 		

APPENDIX E

A Comparison of Asbestos Replacement Products

The materials presented in the chart below are available in a variety of product forms. The aluminum borosilicate, aromatic polyamide, and fiberglass are woven into textiles and are available as cloth tapes and sleeving, fire blankets, welding blankets and personal protective clothing. The alumino silicate material is available as a paper, textile, tapes and sleeving, boards, bulk fiber, cords and yarn, and semi-liquid forms for general refractory repairs.

Property	Chrysotile Asbestos	Fiberglass	Alumino- Silicate	Aluminum Borosilicate
Maximum Continuous Use Temperature (°C)	600	538	1260	593
Degradation Temperature (°C)	up to 1700	700-760 melting point	1790 melting point	1145 melting point
Cloth tensile strength (lbs)	50-200	500-600	65-100	500-600
Fiber tensile strength (MN/m ²)	3100 average	1700	2760	3447
Fiber Diameter (µm)	Fiber 0.03-100 Fibril 0.02	14.7	2-3 average	9
Fiber length (mm)	Fiber 1-80 Fibril 0.25-5	152-254	40-250	continuous filament

APPENDIX F

Distributors of Asbestos-Free Products

A-Best Products Company
3865 West 150th Street
Cleveland, Ohio 44111
216/941-9400

Auburn Manufacturing, Incorporated
Post Office Box 201
Mechanic Falls, Maine 04256
207/345-8771

Waco
Post Office Box 24347
Richmond, Virginia 23224
804/271-0111

Newtex Industries, Incorporated
Railroad Avenue
Post Office Box 25
Victor, New York 14564
716/924-9135

For Encapsulation Materials

KRC Research Corporation
315 North Washington Avenue
Moorestown, New Jersey 08057
609/234-3060

U.S. Coatings Collaborative,
Incorporated
201 Marginal Street
Chelsea, Maryland 02150
617/884-6644

APPENDIX G
Material Safety Data Sheet

Are you getting maximum benefit from OSHA's Material Safety Data Sheets* ?

Information to look for and how it can be used in everyday industrial situations

*(Form OSHA-20)

U.S. DEPARTMENT OF LABOR Occupational Safety and Health Administration		Form Approved OSHA No. 44-R-1387	
MATERIAL SAFETY DATA SHEET			
Required under USDL Safety and Health Regulations for Ship Repairing, Shipbuilding, and Shipbreaking (29 CFR 1915, 1916, 1917)			
SECTION I			
MANUFACTURER'S NAME		EMERGENCY TELEPHONE NO.	
ADDRESS (Number, Dept., City, State, and ZIP Code)			
CHEMICAL NAME AND SYNONYMS		TRADE NAME AND SYNONYMS	
CHEMICAL FAMILY		FORMULA	
SECTION II - HAZARDOUS INGREDIENTS			
PAINTS, PRESERVATIVES, & SOLVENTS	%	TLV (Mg/m ³)	
PIGMENTS			
CATALYST			
VEHICLE			
SOLVENTS			
ADDITIVES			
OTHERS			
ALLOYS AND METALLIC COATINGS		%	TLV (Mg/m ³)
BASE METAL			
ALLOY			
METALLIC COATING			
METAL			
PLUS COATING OR SOPE MIX			
OTHERS			
HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES		%	TLV (Mg/m ³)
SECTION III - PHYSICAL DATA			
BOILING POINT (°F.)		SPECIFIC GRAVITY (H ₂ O=1)	
VAPOR PRESSURE (mm Hg.)		PERCENT VOLATILE BY VOLUME (V)	
VAPOR DENSITY (AIR=1)		EVAPORATION RATE	
SOLUBILITY IN WATER		(H ₂ O=1)	
APPEARANCE AND ODOR			
SECTION IV - FIRE AND EXPLOSION HAZARD DATA			
FLASH POINT (Method used)	FLAMMABLE LIMITS		
EXTINGUISHING MEDIA			
SPECIAL FIRE FIGHTING PROCEDURES			
UNUSUAL FIRE AND EXPLOSION HAZARDS			

by George J. Danke

Recently I heard an OSHA Compliance Officer ask a shop superintendent, "Do you have 'Material Safety Data Sheets' available to you?" The reply was, "Yes, I do and I think having the data would be a great idea if I could understand what it is I'm supposed to get out of it."

Overhearing that conversation made me suspect that the majority of the work force who should benefit from having a "Material Safety Data Sheet," do not because the sheet has not been given to them by their supervisors.

All industries using hazardous ma-

terials can and should be utilizing "Material Safety Data Sheets." Obtaining a Data Sheet on a given product is a relatively simple matter. Most manufacturers of hazardous materials are cooperative and respond to requests for such sheets. The Data Sheet is required under U.S.D.L. Safety & Health Regulations for Ship Repairing, Ship Rebuilding and Ship Breaking (29-CFR 1915-1916-1917). However the form is not restricted to this industry and is available to all. In many cases, purchasing departments and/or purchasing agents have instructions that Form OSHA-20 (Ma-

terial Safety Data Sheet) is to be requested with purchases of all hazardous materials, chemicals, solvents, paint, paint thinners, degreasers, etc.

At this point, it is suggested that consideration be given to conduct an inventory of your operation to be certain that a Data Sheet is available for every hazardous material on the premises. Also, follow this effort with necessary precautions to ensure the safe use of these items. Every member of the management staff should be acquainted with the Data Sheet and be able to interpret its meaning or else have access to

SECTION V - HEALTH HAZARD DATA	
THRESHOLD LIMIT VALUE	
EFFECTS OF OVEREXPOSURE	
EMERGENCY AND FIRST AID PROCEDURES	

SECTION VI - REACTIVITY DATA		
STABILITY	UNSTABLE	CONDITIONS TO AVOID
	STABLE	
INCOMPATIBILITY (Materials to avoid)		
HAZARDOUS DECOMPOSITION PRODUCTS		
HAZARDOUS POLYMERIZATION	MAY OCCUR	CONDITIONS TO AVOID
	WILL NOT OCCUR	

SECTION VII - SPILL OR LEAK PROCEDURES	
STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED	
WASTE DISPOSAL METHOD	

SECTION VIII - SPECIAL PROTECTION INFORMATION		
RESPIRATORY PROTECTION (Specify type)		
VENTILATION	LOCAL EXHAUST	SPECIAL
	MECHANICAL (General)	OTHER
PROTECTIVE GLOVES	EYE PROTECTION	
OTHER PROTECTIVE EQUIPMENT		

SECTION IX - SPECIAL PRECAUTIONS	
PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE	
OTHER PRECAUTIONS	

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Form OSHA-20
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someone in the organization who does have that knowledge and ability.

I have often suggested to manufacturers that a meeting be held with the entire plant administrative staff for the purpose of explaining the meaning and application of the Data Sheet. The following is suggested as a guide for conducting such a program.

1. Someone on staff should be assigned the responsibility for seeing to it that Material Safety Data Sheets are obtained for all hazardous materials in the plant as well as those to be purchased in the future.
2. If special precautions are indicated and the staff is not knowledgeable regarding the

technical applications involved, expert advice from an industrial hygienist, fire protection engineer or chemist should be solicited.

3. Review the form, section by section.

Section I—hazardous material and manufacturer

Pay particular attention to the "Emergency Telephone Number." Should an emergency occur, this information should be readily available.

Every supervisor should be aware of the significance of this section. Having this data available when an emergency occurs can mean the difference between life and death

and/or saving of the physical property.

Section II—hazardous ingredients

TLV (Threshold Limit Values) are published by "The American Conference of Governmental Industrial Hygienists" and have been adopted by OSHA and local authorities. The values tell us the permissible or allowable airborne concentrations of the substance in question for 7 or 8 hour workdays and 40 hour work weeks.

In order to determine the exposure in your area, an industrial hygienist can take readings with special equipment. The hygienist can also advise if there are any problems related to substances in the air.

Armed with this information, necessary steps can be taken to assure that adequate personal protective equipment is available and used. Exhaust systems can be checked to see if they are sufficient to provide the Threshold Limit Values Standards called for.

Section III—physical data (Boiling point—"F.")

In initiating a fire, materials of high boiling points are rarely above their flash points at ambient temperatures and only the more volatile (low boiling point) will be expected to show special hazards. As a rule, the boiling points and the flash points tend to parallel each other and the low boiling point material will greatly diminish its intrinsic danger as a source of fire hazard.

(Vapor pressure—mm Hg.)

Knowledge of the vapor pressure of a particular liquid can be of considerable help to the firefighter. First, it lets him estimate how much vapor is present above the liquid in a closed container. Second, by dividing vapor pressure by 14.7 he can determine the percentage of vapor present. Whether or not this percentage is within the flammable range is easily determined from Standards tables.

The amount of vapor produced by a liquid, at any temperature, is directly related to its vapor pressure and its boiling point. In general, the lower the boiling point of the liquid, the higher its vapor pressure and evaporation rate. In liquids with similar flash points, the one with the

“Several reports of major flammable liquid fires speak of ‘running rivers of fire’ pouring from a building.”

lower boiling point is considered more hazardous.

(Vapor density—AIR=1)

Vapor density is the relative density of a vapor or gas (with no air present) as compared to air. Air is rated as 1 (1.0). A figure of less than 1 indicates a vapor or gas is lighter than air. A figure greater than 1 indicates a vapor or gas is heavier than air. Density, itself, is the weight of a vapor per unit volume at any given temperature and pressure.

Naturally, all vapors heavier than air tend to drop through the air into which they are released until they encounter an obstruction, such as a floor, after which they tend to spread at this level, much in the same manner as if they were liquids. On the other hand, vapors lighter than air tend to rise through the air until an obstruction, such as a ceiling, is encountered after which they spread at the high level.

The tendency is less absolute than with liquids because the difference in density as compared with air is much less than with any liquid, and air currents produce mixing. Some mixing with the air is inevitable and the nearer to air the density is, the greater the mixing.

(Solubility in water)

Information on the degree to which a flammable liquid is soluble in water is useful in determining effective extinguishing agents and methods. Alcohol-resistant type foam, for example, is usually recommended for water soluble liquids. Also, water soluble flammable liquids may be extinguished by dilution. This method is not commonly used because of the amount of water required to make most liquids inflammable; also, there may be danger of nothing in this method if

the burning liquid is heated to over 212°F.

(Appearance and odor)

This will give assistance in identifying the substance, should it become separated from its normal storage place or regular usage.

(Specific gravity—H₂O=1)

For this purpose, specific gravity means the weight of a solid or liquid substance, as compared to the weight of an equal volume of water. The specific gravity of water is, therefore, 1.0. A liquid or solid with a specific gravity of less than 1 will float on water. If its specific gravity is more than 1, it will sink. Water solubility of a liquid has some bearing on whether it will sink or float.

Most flammable liquids (but not all) are lighter than water. Gasoline is an example. Burning gasoline floating on top of running water can spread fire at an awesome rate. Several reports of major flammable liquid fires speak of “running rivers of fire” pouring from a building. The danger to exposure is obvious.

(Percent, volatile by volume [%])

Volatility is determined by the tendency of a liquid or solid to vaporize at ordinary temperature.

Volume indicates the number of cubic feet or liters of solvent formed by the evaporation of a gallon of that liquid at 75°F. or 23.89°C.

Explosive limits are the minimum and maximum concentration of vapor or gas in air or oxygen below or above which explosion does not occur in presence of a source of ignition. The explosive or flammable limits are usually expressed in terms of percentage by volume of vapor in the air. Range indicates the area between the lower and higher explosive limits.

Explosion venting is provided for

the release of high pressures caused by explosions.

(Evaporation rate) (----=1)

Evaporation rate is the rate at which a liquid is converted to the vapor state at any given temperature and pressure. All materials evaporate; it is the differing rates of evaporation of mixtures that is of primary concern to fire protection. In general, as the boiling point decreases, the vapor pressure and the evaporation rate increases. Knowing the physical data of a product gives a guideline for proper handling and salvage of the item.

Section IV—fire and explosion hazard data

(Flash point—method used)

This is the lowest temperature at which a mixture of the vapor of a liquid and surrounding air which can be ignited is formed. It can be measured by means of two different methods, a closed cup and an open cup.

(Extinguishing media)

The information contained here will advise you as to the type of fire protection emergency equipment that needs to be available where the subject material is present.

(Special fire fighting procedures)

When the material is received and is found to be exceptionally hazardous, an effort should be made to determine how a fire would be fought should one develop, and arrangements made to have the proper extinguishing material on hand and personnel properly instructed in the use of this material.

(Unusual fire and explosion hazards)

Here again, particular attention should be given to the manufacturer's recommendations for fire fighting procedures and equipment

required for this particular material. In these cases, preparation for the prevention of fire and the provision of proper fire protection equipment should commence at the time the material is ordered.

(Flammable limits)

L.E.L.—Lower Explosive Limits

U.E.L.—Upper Explosive Limits

The above readings are taken with an explosion meter and advise as to the explosibility of a given substance. Concentrations of vapor below the lower explosion limits are too lean to cause explosion and concentrations above the upper explosion limits are too rich to allow explosion. Readings taken which indicate a concentration between the lower explosive limits and upper explosive limits are in the range where an explosion could occur. A careful review of this information will outline the fire fighting and fire protection needs for the product.

Section V—Health hazard data

All supervisors should be familiar with the meaning of T.L.V. Then they will understand and refer to proper reference material to determine the effects of overexposure. Precautions can be taken from standpoint of emergency and first aid procedures.

Section VI—Reactivity data

The importance of acquainting production supervisors with basic knowledge in this area cannot be over-emphasized. Only then can they fully appreciate the need for the kinds of protection required. If the supervisor does not understand the following, how can he know what conditions to avoid?

Stability

Unstable materials polymerize, decompose, condense or become self-reactive when exposed to air, water, heat, shock or pressure.

Stable materials are materials which normally have the capacity to resist changes in their chemical composition despite exposure to air, water, heat, shock or pressure. Stable materials may burn. For example, most solids fall into this category.

Section VII—Spill or leak procedures

Manufacturers advise as to what

needs to be done, should a material leak from a tank or be spilled on the floor. Pay special attention to these instructions as some materials can be extremely dangerous when spilled.

In many instances, waste disposal can result in very serious consequences if not handled properly. You should know if the material can be incinerated, taken to a dump or disposed of in sewers.

If, after pursuing the special protection information, it is noted that the necessary equipment is not on hand, the product should not be released for use until the equipment is available. Firm guidelines for these areas need to be set and endorsed if problems are to be avoided. Perhaps an audit to determine how your facility stands in this area would be in order.

Section VIII—Special protection information

If the type of respiratory protection recommended is not available, see to it that the proper type is obtained and the use of it enforced.

Information relative to ventilation can be of vital importance in the proper storage and use of the substance for which the data sheet is written. If proper exhaust is not available, see the maintenance department and have arrangements made to satisfy the need. Assistance may be required to check ventilation equipment to determine its adequacy.

Eye protection, protective gloves and other protective equipment is an area requiring careful scrutiny. Too often we make do with what we have on hand rather than obtaining recommended safety equipment. Employees must be taught proper use and care of these articles. ☼

References

1. *Handbook of Industrial Loss Prevention* prepared by the Staff of the Factory Mutual Engineering Division, McGraw-Hill Book Company, Inc.—1959.
2. *National Fire Protection Association's Fire Protection Handbook*, 14th Edition, published by The National Fire Protection Association, Boston, Massachusetts—Copyright 1976. In particular, page 3-20 "Evaporation Rate."

If the supervisor does not understand . . . how can he know what conditions to avoid?

APPENDIX H

RESPIRATORS NAMES AND ADDRESSES OF MANUFACTURERS AND DISTRIBUTORS

Ace Enterprises, 826 Northwest 144th St., Miami, FL 33168.
Acme Automotive Finishes, 101 Prospect Ave., Cleveland, OH 44115.
American Optical Corp., Safety Products Div., 14 Mechanic Street, Southbridge, MA 01550.
Anderson Manufacturing Co., 1014 Fox Chase Road, Rockledge, PA 19111.
Bendix Corporation, P. O. Drawer 831, Lewisburg, WV 24901.
Binks Manufacturing Co., 9201 W. Belmont Ave., Franklin Park, IL 60131.
BioMarine Industries, Inc., 45 Great Valley Center, Malvern, PA 19355.
Bowen Tools, Inc., P.O. Box 3186, Houston, TX 77001.
Browning Ferris Industries, Fannin Bank Building, Houston, TX 77025.
Bullard, E. D., Co., 2680 Bridgeway, Sausalito, CA 94965.
Cesco Safety Products, Parmelee Industries, Inc., P.O. Box 1237, Kansas City, MO 64141.
Clemco Industries, 2177 Jerrold Ave., San Francisco, CA 94124.
Clemtex, Ltd., 248 McCarthy Drive, Houston, TX 77020.
Cover, W. S. Co., 107 East Alexander St., Buchanan, MI 49107.
Defense Apparel, 285 Murphy Road, Hartford, CT 06114.
DeVilbiss Company, 300 Phillips Ave., P.O. Box 913, Toledo, OH 43692.
Dragerwerk, AG, D-24 Luebeck 1, Postfach 1339, WEST GERMANY.
Eastern Safety Equipment Co., 45-17 Pearson St., Long Island City, NY 11101.
Empire Abrasive Equipment Corp., 9990 Gantry Road, Philadelphia, PA 19115.
Encom Manufacturing Co., 4914 Dickson St., Houston, TX 77007.
Fiber-Metal, P.O. Box 248, Concordville, PA 19331.
Glendale Optical Co., 130 Crossways Park Drive, Woodbury, NY 11797.
Globe Safety Products, Inc., 125 Sunrise Place, Dayton, OH 45407.
Kelco Sales and Engineering Co., P.O. Box 422, Norwalk, CA 90650.
Key Houston, Inc., 13911 Atlanta Blvd., Jacksonville, FL 32225.
Lear Siegler, Inc., 714 North Brookhurst St., Anaheim, CA 92803.
Mohawk Industrial Supply Company, P.O. Box 945, Manchester, CT 06040.
Mine Safety Appliances Co., 400 Penn Center Blvd., Pittsburgh, PA 15235.
3M Company, 3M Center, Building 230-H, St. Paul, MN, 55101.
Northcott Products Co., 1826 W. Diversey Parkway, Chicago, IL 60614.
Norton Safety Products, 2000 Plainfield Pike, Cranston, RI 02920
Pauli and Griffin, 137 Utah Ave., South San Francisco, CA 94080
Pulmosan Safety Equipment Corp., 30-48 Linden Place, Flushing, NY 11354.
Robertshaw Controls Co., 333 North Euclia Way, Anaheim, CA 92803.
Safe-Tex, Toronto, Ontario, CANADA.
Safety and Supply Co., 5510 East Marginal Way South, Seattle, WA 98134.
Schmidt Manufacturing Inc., Houston, TX.
Scott Aviation, Division of ATO, Inc., 225 Erie Street, Lancaster, NY 14086.
Sellstrom Manufacturing Co., 59 E. Van Buren St., Chicago, IL 60605.
Siebe Gorman, Ltd., Chessington Surrey, ENGLAND
Standard Safety Equipment Corp., P.O. Box 188, Palantine, IL 60067.
Stewart-warner, Chicago, IL.
SurvivAir, Division of U.S. Divers Co., 3323 W. Warner Ave., Santa Ana, CA 92702.
Titan Abrasive Systems, Inc., P.O. Box 3, Furlong, PA 18925.
United States Safety Service, Parmelee Industries, Inc., P.O. Box 1237, Kansas City, MO 64141.
Willson Division, ES8 Incorporated, 2nd and Washington Sts., Reading, PA 19603.

APPENDIX I

Respirator Limits for Asbestos Exposure

Limit	Respirator Type	Description
Up to 10 times permissible limit*	Air-purifying respirator, disposable or single-use type	Filters trap asbestos fibers on surface
Up to 100 times permissible limit*	Powered air-purifying respirator, full face-piece	Self-contained, battery-operated unit which forces fresh air into the mask
Up to 1000 times permissible limit*	Type "C" supplied-air respirator, continuous-flow or pressure-demand class	Central compressor supplies air to mask through connected air lines, or through use of a tank.

*Permissible exposure limit is two asbestos fibers/cc³ averaged over an eight-hour shift. No worker may be exposed to airborne concentrations in excess of this limit.

All respirators must be NIOSH-approved.

APPENDIX J

Manufacturers and Distributors of Protective Clothing

A-Best Products Company
3865 West 150th Street
Cleveland, Ohio 44111
216/941-9400

Neese Industries, Incorporated
Post Office Box 628
Gonzales, Louisiana 70737
504/644-6553

Waco
Post Office Box 24347
Richmond, Virginia 23224
804/271-0111

Durafab
Post Office Box 658
Cleburne, Texas 76031
817/645-8851

Newtex Industries, Incorporated
Railroad Avenue
Post Office Box 25
Victor, New York 14564
716/924-9135

Bullard Safety
2105 West Amherst Avenue
Englewood, Colorado 80110
303/761-5100

Union Safety Products
5460 Colorado Boulevard
Denver, Colorado 80216
303/534-2202

Norton Safety Products
2000 Plainfield Pike
Cranston, Rhode Island 02920
401/943-4400

Roe
4255 Jason Street
Denver, Colorado 80211
303/433-8901

Duncan Supply, Incorporated
2650 South Zuni Street
Englewood, Colorado 80110
303/922-3679

APPENDIX K

Manufacturers and Distributors of Asbestos Vacuums

Waco
Post Office Box 24347
Richmond, Virginia 23224
804/271-0111

Nilfisk of America, Incorporated
201 King Manor Drive
King of Prussia, Pennsylvania 19406
215/277-3900

American Cleaning Equipment Corporation
111 South Route 53
Addison, Illinois 60101
312/627-6900

APPENDIX L

Manufacturers and Distributors
of Wetting Agents for the Wet Removal of Asbestos

Aquatrols Corporation of America
1400 Suckle Highway
Pennsauken, New Jersey 08110

Occidental Chemical Company
Institutional Division
Box 198
Lathrop, California 95330

Target Chemical Company
1280 North Tenth Street
San Jose, California 95112

Vineland Chemical Company
Box 745
Vineland, New Jersey 08360

Leffingwell Chemical Company
Box 188
Brea, California 92921

Rohm and Haas Company
Agricultural Chemical Department
Independence Mall
West Philadelphia, Pennsylvania 19105

Thompson-Hayward Chemical Company
Box 2383
Kansas City, Kansas 66110

APPENDIX M
Policy Statement for Asbestos Waste



COLORADO DEPARTMENT OF HEALTH

4210 EAST 11th AVENUE · DENVER, COLORADO 80220 · PHONE 320-8333

August 20, 1979

TO: County Commissioners
Environmental Health Directors
County Sanitarians

SUBJECT: POLICY STATEMENT FOR ASBESTOS WASTES

The Environmental Protection Agency has recently undertaken a program to remove from public buildings certain asbestos-containing construction materials because airborne asbestos fibers represent serious respiratory hazards, including increased risk of lung cancer. Mesothelioma, a cancer of certain tissues in the lung cavity, has long been associated with industrial exposure to asbestos fibers; recent discovery that asbestos construction materials have produced airborne fibers has led to concern of increased respiratory hazards to occupants of public buildings, especially schools. Individual fibers are invisible to the naked eye and remain suspended for prolonged periods once airborne. Since the fibrous material is a mineral, it persists in the environment essentially forever, and can be a source of exposure anytime in the future should it become airborne.

Control Policy

The production of asbestos-containing waste from the EPA-supported remedial action program and the inherent hazard and persistence of the material have led this Department to require the following measures for the protection of Colorado citizens due to the handling and disposal of asbestos wastes:

1. Removal, Handling, and Containerization of materials containing asbestos from any public buildings in Colorado shall be in accordance with specifications provided in EPA Publication No. EPA 450/2-78-014 entitled "Asbestos-Containing Materials in School Buildings - A Guidance Document". Removal, handling and containerization operations can be safely conducted if the respiratory protection measures and wetting-down procedures contained in the EPA specifications are followed. The Containerization Specifications require packing friable asbestos-containing materials (defined as any material that contains more than one percent asbestos by weight that can be crumbled, pulverized, or reduced to powder, when dry, by hand pressure) in plastic bags and placement of these in sealed fiber or metal drums. If so contained, the material will be acceptable for shipment by conventional means.

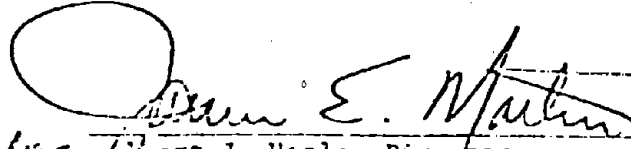
2. Transportation of containerized asbestos-containing materials shall provide for labelling of all bags and shipping drums with a warning that states: "Caution, Contains Asbestos, Avoid Opening or Breaking Container, Hazardous if Inhaled, If Spilled - Cover or Use Wetting Agent to Prevent becoming Airborne."

3. Disposal of friable asbestos-containing wastes in the State of Colorado shall be permitted only at a site approved to receive such wastes and which is operated in accordance with provisions stated below. A site must be able to: a) assure long-term care under either state or federal oversight, b) provide for a specific location within the property for all asbestos wastes received, c) provide daily cover in accordance with EPA Regulations (40 CFR, 61, B, 61.25) and at least 2 feet of final earth cover for the wastes, and d) maintain a permanent record of the location and quantity of wastes disposed. These requirements are instituted in order that these hazardous materials will pass to future generations in a confined well-known location. Although many sites are sufficient to contain asbestos wastes safely, these long-term care considerations are required so that future generations may provide whatever protection they may think necessary with minimal effort. The Lowry Landfill site outside the metropolitan area of Denver, Colorado now meets these basic requirements and is approved for accepting and disposing of friable asbestos-containing wastes.

4. Disposal Operations at approved sites shall be conducted in a manner so that workers unloading sealed drums or bags containing friable asbestos-containing wastes and equipment operators working on the disposal of such wastes are protected from inhalation hazards by proper respiratory protection and the use of wetting solutions when necessary. The sealed bags containing asbestos wastes may be removed from the shipping drums at the site, and the drums reused except that, if a bag is broken or damaged, the bag shall be buried inside the drum. The site operator shall provide supervision of the disposal operation sufficient to meet these requirements. The disposal area shall be posted, and other measures necessary to prevent the disposed and covered material from being excavated or otherwise becoming airborne shall be undertaken.

Effective Date

This policy for removal, handling, containerization, and disposal of friable asbestos-containing materials is effective August 20, 1979 and supercedes interim requirements previously issued by this Department.


for Robert J. Hazle, Director
Radiation and Hazardous
Wastes Control Division

APPENDIX N

Manufacturers and Distributors
of Labels for Asbestos Waste Materials

Nanco Enterprises, Incorporated
Post Office Box 52742
Houston, Texas 77052
713/644-2544

Stonehouse Signs, Incorporated
Post Office Box 546
Arvada, Colorado 80001
303/422-2356

UNZ and Company
190 Baldwin Avenue
Jersey City, New Jersey 07303
800/631-3098

APPENDIX O

Sources of Information—Organizations and Publications

ORGANIZATIONS

1. Institute of Rural Environmental Health
Occupational Health and Safety Section
110 Veterinary Science Building
Colorado State University
Fort Collins, Colorado 80523
2. Asbestos Workers International Union
1300 Connecticut Avenue, N.W.
Washington, D.C. 20036
3. Health Research Group
2000 P Street, N.W. No. 708
Washington, D.C. 20036
4. National Institute of Environmental Health Sciences
Public Information Officer
P.O. Box 12233
Research Triangle Park, North Carolina 27709
5. Oil, Chemical and Atomic Workers International Union
P.O. Box 2812
Denver, Colorado 80201
6. Mt. Sinai School of Medicine
Environmental Sciences Laboratory
5th Avenue and 100th Street
New York, New York 10027
7. Scientist's Institute for Public Information, New York
355 Lexington Avenue
New York, New York 10022
8. Labor Occupational Health Program
2515 Channing Way
Berkeley, California 94720
9. Western Institute for Occupational/Environmental Sciences, Inc.
2001 Dwight Way
Berkeley, California 94704
10. Food and Drug Administration
Parklawn Building
Rockville, Maryland 20850
11. Johns-Manville Corporation
Health, Safety and Environment Department
Ken-Caryl Ranch
Denver, Colorado 80217
12. Colorado Department of Health
4210 East 11th Avenue
Denver, Colorado 80220

13. Colorado Department of Education
State Office Building
201 East Colfax Avenue
Denver, Colorado 80203
14. Cancer Information Clearing House
National Cancer Institute
Office of Cancer Communications
9000 Rockville Pike, Building 31, Room 10A18
Bethesda, Maryland 20205
15. Regional Health Administration
DHHS, Region VIII
11037 Federal Building
Denver, Colorado 80294
16. National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, Ohio 45226
17. National Institute for Occupational Safety and Health
DHHS Region VIII
11037 Federal Building
Denver, Colorado 80294
18. Occupational Safety and Health Administration
200 Constitution Avenue, N.W.
Washington, D.C. 20201
19. Occupational Safety and Health Administration
USDOL Region VIII
Room 1554/1961 Stout Street
Denver, Colorado 80294
20. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460
21. Environmental Protection Agency
Region VIII
1860 Lincoln Street
Denver, Colorado 80295
22. Consumer Product Safety Commission
1111 18th Street, N.W.
Room 303
Washington, D.C. 20207

PUBLICATIONS

1. Asbestos Containing Materials in School Building: A Guidance Document, Parts 1 and 2. 1971. Booklets.
Avail: Environmental Protection Agency, 1860 Lincoln Street, Denver, CO 80295.
Telephone: (303) 837-3926.
2. Asbestos Disease — Are You Covered? K. W. Carlson; R. A. Fowler. Brochure.
Avail: Western Institute for Occupational/Environmental Sciences, Inc.;
2001 Dwight Way, Berkeley, CA. 94704
Telephone: (415) 845-6476.
3. Asbestos Exposure: A Desk Reference for Communicators. May 1978. Booklet:
Order No. NIH-79-1622.
Avail: National Cancer Institute, Office of Cancer Communication, Bldg. 31,
Rm. 10A18, 9000 Rockville Pike, Bethesda, MD 20205.
Telephone: (301) 496-5583
4. Asbestos Exposure: What It Means, What To Do. 1978. Brochure: Order No.
NIH-79-1566.
Avail: National Cancer Institute, Office of Cancer Communications, Bldg. 31,
Rm. 10A18, 9000 Rockville Pike, Bethesda, MD 20205.
Telephone: (301) 496-5583.
5. Cancer Information in the Workplace: Annotated Bibliography of Educational
Materials for the Public and Health Professionals. May 1979. Booklet: Order
No. NIH-79-2001.
Avail: National Cancer Institute, Office of Cancer Communications, Bldg. 31,
Rm. 10A18, 9000 Rockville Pike, Bethesda, MD 20205.
Telephone: (301) 496-5583.
6. Carcinogens: Regulation and Control. 1977. Brochure: Order No. NIOSH-77-205.
Avail: National Institute for Occupational Safety and Health, Publications
Office, 4676 Columbia Parkway, Cincinnati, OH 45226.
Telephone: (513) 684-4287.
7. Health Hazards of Asbestos: Series: Cancer Alert. George Washington Univer-
sity Medical Center, Science Communication Division. 1979. Brochure: Order
No. OSHA-3040.
Avail: U.S. Department of Labor, Occupational Safety and Health Administration,
Office of Publications, RM. N-3423, 200 Constitution Ave., N.W.,
Washington, D.C. 20201.
Telephone: (202) 523-6138.

8. OSHA: Your Workplace Rights in Action. 1978. Brochure: Order No. OSHA-3032.
Avail: U.S. Department of Labor, Occupational Safety and Health Administration,
Office of Publications, Rm. N-3423, 200 Constitution Ave., N.W.,
Washington, D.C. 20201.
Telephone: (202) 523-6138
9. What You Need to Know About Cancer. 1979. Brochure: Order No. NIH-79-1566.
Avail: National Cancer Institute, Office of Cancer Communications, Bldg. 31,
Rm. 10A18, 9000 Rockville Pike, Bethesda, MD 20205.
Telephone: (301) 496-5583.
10. The Asbestos Hazard. P. Brodeur. 1980. Book.
Avail: The New York Academy of Sciences, 2 East 63rd Street, New York, NY 10021.
11. Update on Asbestos. A. Labbauf. 1980. Booklet.
Avail: Penn Environmental Health, 6938 Meade Street, Pittsburgh, PA 15208
12. Asbestos Dust: Everyone's Problem. R. A. Fowler. Booklet.
Avail: Western Institute for Occupational/Environmental Sciences, Inc., 2001
Dwight Way, Berkeley, CA 94704.
Telephone: (415) 845-6476.
13. Plan Talk About Asbestos. R. A. Fowler; P. L. Polakoff. 1978. Booklet.
Avail: Western Institute for Occupational/Environmental Science, Inc., 2001
Dwight Way, Berkeley, CA 94704.
Telephone: (415) 845-6476.
14. Asbestos: The Need for and Feasibility of Air Pollution Controls. 1971.
Booklet.
Avail: National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington,
D.C. 20418.
15. Asbestos: An Information Resource. 1978. Booklet: Order No. NIH-79-1681.
Avail: National Cancer Institute, Office of Cancer Communications, Bldg. 31,
Rm 10A18, 9000 Rockville Pike, Bethesda, MD 20205.
Telephone: (301) 496-5582.

APPENDIX G

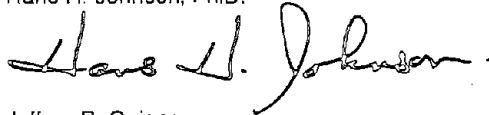
"ACTION TIPS" NEWSLETTERS REFERENCING ASBESTOS

Construction Health Hazards Prevention

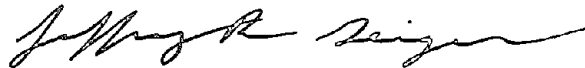
Action Tips

Construction Health Hazards Education Program
Institute of Rural Environmental Health
Occupational Health and Safety Section
110 Veterinary Science Building
Colorado State University
Fort Collins, Colorado 80523
303/491-6151

Hans H. Johnson, Ph.D.



Jeffrey R. Geiger
Industrial Hygienist



ASBESTOS: WHY BE CONCERNED?

Asbestos is one of the most widely recognized construction health hazards. In addition to causing asbestosis, a debilitating lung disease, it is also an established carcinogen. It is estimated by HEW that up to two million excess cancer deaths will occur in the U.S. over the next 30 years as a result of past asbestos exposures. Asbestos is a topic of vital concern to all involved with construction.

ASBESTOS MAY BE MORE COMMON THAN YOU THINK

There exists a dangerous misconception among some persons in the construction industry that the U.S. government has banned the use of asbestos. While certain limitations have been imposed by the Environmental Protection Agency and the Consumer Product Safety Commission (and further restrictions are currently under consideration by both agencies), this by no means has eliminated the use of asbestos. Over 800 million tons of this mineral fiber are used annually in this country, and over two thirds of its 3000 uses are in construction. Even if it would be banned in the future, asbestos will be a continuing hazard in maintenance, remodeling, and demolition for many years to come. A few of its current construction

uses include: floor tile, roofing materials, drywall compounds, gaskets, packing materials, electric insulation, corrosion resistant coatings, heat resistant materials, and asbestos cement pipe and sheet.

HAZARD RECOGNITION IS THE FIRST STEP

To determine if asbestos is used in a specific product, first check the label. Additional information can be obtained by requesting a Material Safety Data Sheet (MSDS) from the manufacturer. The data sheet should list any hazardous substances that are present in the product. If in doubt, play it safe. Even short exposures to asbestos may be harmful.

Positive identification of asbestos can be made by laboratory analysis of bulk samples of the suspected materials and/or workplace air samples. Bulk samples are simple to obtain; you may be able to do this yourself. Collection of air samples requires more elaborate techniques and are best performed by a specialist, usually an industrial hygienist. A number of private and government laboratories offer asbestos analysis service. Remember, the fibers that can enter the body and cause damage are too small to be seen with the naked eye. If in doubt seek professional help.

WHERE TO GO FOR HELP

We would be happy to assist you with any questions you may have. Additional resources include:

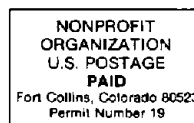
AGENCIES

- * Consumer Products Safety Commission, Telephone (800) 638-2666
- * NIOSH - Region 8, Telephone (303) 837-3979
- * OSHA - Region 8, Telephone (303) 837-3883
- * EPA - Region 8, Telephone (303) 837-3926
- * NCI - Cancer Information Service; Telephone Colorado (800) 332-1850, Wyoming and Montana (800) 525-0231, Utah and North and South Dakota (800) 638-6694

PUBLICATIONS

- * Health Hazards of Asbestos (OSHA 3040), OSHA Publication, USDOL, Room N 3423, Washington, D.C. 20210
- * Asbestos Exposure (DHEW/NIH 79-1622), Office of Cancer Communications, National Cancer Institute, Bethesda, Maryland 20014

Occupational Health and Safety Section
Institute of Rural Environmental Health
110 Veterinary Science Building
Colorado State University
Fort Collins, Colorado 80523

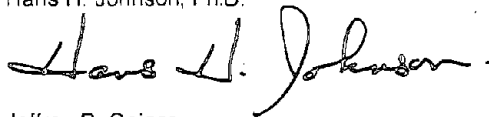


Construction Health Hazards Prevention

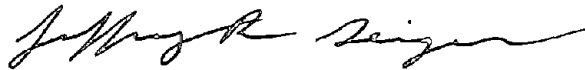
Action Tips

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Fort Collins, Colorado 80523
303/491-6151

Hans H. Johnson, Ph.D.



Jeffrey R. Geiger
Industrial Hygienist



SAFE ASBESTOS TREATMENT STEP #1: DETERMINE IF ASBESTOS IS PRESENT

The first step in assessing a potential asbestos problem is to know for sure whether or not a material contains asbestos. This usually means collecting a sample of the material and sending it to a laboratory for analysis.

WHERE TO LOOK? — Common places to look for asbestos containing materials include:

1. ceilings, or walls with sprayed-on insulation;
2. ceiling, floor, wall tiles or panels;
3. beams with sprayed-on insulation;
4. pipe coverings;
5. boiler insulation;
6. fire walls and doors; and
7. around or in ductwork.

ONLY A SMALL AMOUNT OF MATERIAL IS NEEDED FOR ANALYSIS — ABOUT THE SIZE OF A SUGAR CUBE

ACTION TIPS → COLLECTING AND ANALYZING SAMPLES

To collect samples, you will need:

- a tightly sealable non-breakable container, such as a plastic 35mm film canister or zip-lock baggie;
- a scraping or cutting tool, such as a pen knife, putty knife, or sheetrock knife;
- an asbestos approved dust mask.

NOTE: It is important to take precautions against getting dust and pieces of debris on your body and on your clothing. (You don't want to take the stuff home with you!)

Laboratories only need a small amount of material for analysis. You might wish to call a laboratory (a list is provided below) for any special instructions they may have on packaging and shipping the sample, and to ask them what the cost will be. Costs often vary from laboratory to laboratory. If more than one sample is to be sent, each sample container should be labelled with a code telling you where the sample was collected. The laboratory will report their findings using your codes, so you should keep a record including an explanation of the codes you use. In your communications with the laboratory, indicate that you want to know what type of asbestos (chrycotile, amosite, etc.) is in your sample and in what percent. The type and percent of asbestos is important information when deciding what should be done with the material, if anything.

The following regional laboratories are qualified to perform asbestos analyses:

Colorado School of Mines
Research Institute
P.O. Box 112
Golden, CO 80401
(303)279-2581

Hagar Laboratories
12000 East 47th Avenue
Denver, CO 80239
(303)371-1441

Southwestern Labs
P.O. Box 10687
Dallas, TX 75207
(214)688-0088

Petrography Consultants
31720 Hilltop Road
Golden, CO 80401
(303)642-7559

Boeing Technology
Services, 9R-25
P.O. Box 3707
Seattle, WA 98124
(206)237-2722

Utah Biomedical Test
Laboratory
520 Wakara Way
Salt Lake City, UT 84108
(800)453-5653

NOTE: In some cases it may be necessary to patch-up places where a sample has been taken. For example, duct tape over a hole in pipe lagging.

Occupational Health and Safety Section
Institute of Rural Environmental Health
110 Veterinary Science Building
Colorado State University
Fort Collins, CO 80523

NONPROFIT
ORGANIZATION
U.S. POSTAGE
PAID
Fort Collins, Colorado 80523
Permit Number 19

Construction Health Hazards Prevention

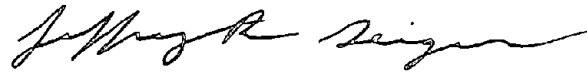
Action Tips

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Institute of Rural Environmental Health
Occupational Health and Safety Section
110 Veterinary Science Building
Colorado State University
Fort Collins, Colorado 80523
303/491-6151

Hans H. Johnson, Ph.D.



Jeffrey R. Geiger
Industrial Hygienist



SAFE ASBESTOS TREATMENT STEP #2: ASSESSING THE EXTENT OF AN ASBESTOS PROBLEM

There are six major factors to consider when assessing the extent of an asbestos problem:

1. The PERCENT OF ASBESTOS in the material,
2. The overall CONDITION of the material,
3. The ACCESSIBILITY or ease with which the material may be touched or disturbed,
4. The degree of AIR MOVEMENT around the material,
5. The amount and type of ACTIVITY that goes on in the area, and
6. The FRIABILITY or ease with which the material may be broken apart.

When collecting samples of potential asbestos-containing materials for laboratory analysis (see Action Tips, A-9) it is a good idea to take a few notes on the above mentioned factors. These notes will be useful, after you have the laboratory results, in making a decision on what should be done with the material.

The form on the reverse side of this sheet provides an easy way to assess the hazard potential of each sample collected for analysis.

An Evaluation Aid in Assessing Potential Asbestos Exposure

NOTE OF CAUTION: This evaluation aid is presented to provide general guidance. If there is any question as to the potential for asbestos exposure to building users, professional consultation is necessary.

Directions for use

1. For each of the 6 factors, circle the most appropriate numerical value (circle only one number per factor).
2. Add up all of the circled numbers, and refer to the "Action Suggestions."

NOTE: The minimum total value is 6, and the maximum total value is 19.

PERCENT ASBESTOS: The amount of asbestos contained in the material. (NOTE: This will be indicated on the laboratory analysis report.)

Numerical Value	Evaluation Category
1	One to 10 percent
2	Eleven to 25 percent
3	Twenty-six to 50 percent
4	Fifty-one percent or more

CONDITION: The degree of deterioration and damage of asbestos-containing material.

Numerical Value	Evaluation Category
1	No damage at all.
2	Slight to moderate damage; (e.g., small chips missing from ceiling tiles; mild water stains on ceilings; loose pipe wrapping)
3	Severe damage; (e.g., scored or punctured pipe lagging, loosely hanging material, severe water damage, etc.)

ACCESSIBILITY: The relative ease with which the asbestos-containing material may be reached or disturbed.

Numerical Value	Evaluation Category
1	Totally enclosed/encapsulated or tightly bound; (e.g., pipe lagging behind enclosed radiators; floor tiles unless scored or sanded)
2	Generally inaccessible; (e.g., ceiling tiles and spray-on beyond normal hand reach or potential damage from thrown objects; pipe lagging in locked closet)
3	Accessible; (e.g., pipe lagging, ceiling, etc., within hand reach or subject to damage from thrown objects)

AIR MOVEMENT: The degree to which asbestos fibers may accumulate at sample site.

Numerical Value	Evaluation Category
1	Presence of mechanical air moving system which exhausts air to building exterior.
2	Limited air movement; (i.e., open doors and windows, ceiling fan, etc.)
3	Essentially no air movement.

ACTIVITY: The potential, because of room use, for damage to asbestos-containing material.

Numerical Value	Evaluation Category
1	Low activity area; (e.g., closets and storage rooms; conference room; offices; boiler room)
2	Moderate activity areas; (e.g., locker room; shops)
3	High activity areas. (e.g., gymnasium; auditorium; cafeteria; hallways and stairways; swimming pool; all purpose rooms)

FRIABILITY: The ease with which the asbestos-containing material may be broken apart.

Numerical Value	Evaluation Category
1	Nonfriable; (i.e., potential asbestos firmly bound such as in some floor tiles and pipes; material cannot be broken or fractured with hands)
2	Moderately friable; (i.e., material may be broken or fractured with hands, but breaks up in relatively large pieces)
3	Very friable; (i.e., material is easily broken apart with hands and easily crumpled with fingers)

Numerical Value Total
(Add up circled numbers)

Action Suggestions

If total value equals 6-8 → Defer Action

If it is determined that the exposure is negligible or that there is no potential exposure, action can be deferred. However, a continuing inspection program is necessary to ensure that if the situation changes, steps will be taken to control exposure.

If total value equals 9-19 → Corrective Action

This may include removal, encapsulation, or enclosure. A professional should be consulted in making this decision.

Construction Health Hazards Prevention

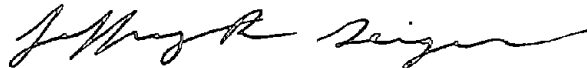
Action Tips

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Occupational Health and Safety Section
110 Veterinary Science Building
Colorado State University
Fort Collins, Colorado 80523
303/491-6151

Hans H. Johnson, Ph.D.



Jeffrey R. Geiger
Industrial Hygienist



SAFE ASBESTOS TREATMENT STEP #3: SELECTION OF A CONTROL METHOD

After a building has had a careful assessment and analysis for asbestos, you will know if any action is necessary.

Asbestos control is most commonly done by using one of the following methods:
Removal - Encapsulation - Enclosure

Removal involves stripping the asbestos from its location and disposing of it in an approved burial site.

Encapsulation involves the use of a sealing agent that is sprayed onto the asbestos to prevent its fibers from being released into the air. Enclosure involves the building of a barrier to separate the asbestos from the general environment, such as by installing a dropped ceiling, a false wall, or by building a box around it. While removal offers a permanent solution to the problem, it may not always be feasible or cost effective. In fact, it may even cause a greater hazard than originally exists if it is done improperly! Encapsulation and enclosure are effective treatments which can be much less costly, but the asbestos material still remains to be dealt with at a future date. The following table can serve as a guide to the advantages, disadvantages, and appropriate situations for the use of each of these asbestos control methods!

"This material has been funded in whole or in part with Federal funds from the Occupational Safety and Health Administration, U.S. Department of Labor, under grant number E1F0D 301. Individuals undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment. Therefore, these materials do not necessarily reflect the views or policies of the U.S. Department of Labor, nor does mention of trade names, or organizations imply endorsement by the U.S. Government."

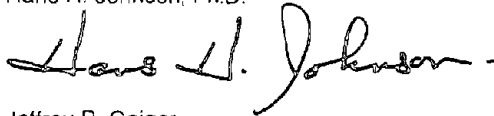
METHOD	ADVANTAGES	DISADVANTAGES	WHEN TO USE	WHEN NOT TO USE
Removal	Eliminates the exposure problem by removing the source	<p>Will create a high potential exposure to workers and the surrounding environment during removal</p> <p>It is the most involved, expensive, and time-consuming method</p> <p>The asbestos may need to be replaced with a substitute material</p>	<p>Whenever possible, such as on flat, open surfaces.</p> <p>If the material is damaged, deteriorating, or causing a high exposure</p> <p>If it is easily accessible and likely to be damaged</p>	Whenever careful and complete removal is not feasible due to time restrictions, cost restrictions, or inaccessibility
Encapsulation	Controls the exposure in a rapid, economical manner	<p>The asbestos material remains to be dealt with at a later time</p> <p>The weight of the sprayed-on encapsulating material may cause loosely bonded asbestos to come loose</p> <p>Requires continual inspection to check for any future damage</p> <p>Special precautions will be necessary during future maintenance, remodeling, or demolition operations</p>	<p>When removal is not feasible</p> <p>Only if the material is sound enough to support the weight of the encapsulating material and inaccessible to future damage</p> <p>Over complex surfaces</p> <p>When economics or time are a key factor</p>	<p>When removal can be done</p> <p>When the material is in poor condition or damage is likely to occur</p> <p>If continued inspection and maintenance of the area cannot be ensured</p> <p>If contact damage can still occur</p>
Enclosure	Controls the exposure in a rapid, economical manner	<p>The asbestos material remains to be dealt with at a later time</p> <p>Fibers may fall out from behind the enclosure</p> <p>Can be costly if pipes or other fixtures must be relocated</p> <p>Precautions are necessary for later remodeling or demolition</p> <p>Continued surveillance is necessary to check for any further damage</p>	<p>If removal is not feasible</p> <p>If disturbances or the need for entry into the enclosure is not likely</p> <p>When economics and time are key factors</p>	<p>If removal is feasible</p> <p>If the material is damaged or deteriorated to the point of causing high fiber fallout</p> <p>If entry into the area is necessary for maintenance or repairs</p> <p>If continued inspection and maintenance can not be performed</p>

Construction Health Hazards Prevention

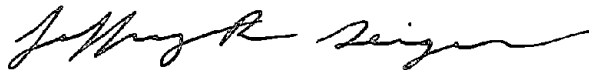
Action Tips

Construction Health Hazards Education Program
Institute of Rural Environmental Health
Occupational Health and Safety Section
110 Veterinary Science Building
Colorado State University
Fort Collins, Colorado 80523
303/491-6151

Hans H. Johnson, Ph.D.



Jeffrey R. Geiger
Industrial Hygienist



SAFE ASBESTOS TREATMENT Step #4-A: Removal

When deciding on how to treat asbestos-containing materials, you should consider removal if the material is severely damaged or easily accessible and likely to be damaged. (See Action Tips A-11). Removal should also be considered if you have used the evaluation aid presented in Action Tips A-10, and obtained a high score.

An asbestos removal job will require that you obtain a variety of materials and become familiar with their proper and intended use prior to beginning work. These materials usually include plastic sheeting, disposable clothing, filter cartridge or air-line respirators, wetting agent and sprayer, goggles, gloves, warning signs, plastic bags, 55-gallon drums, and an asbestos vacuum cleaner.

The key to a safe asbestos removal job is to plan ahead.

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Action Tips — Steps to follow when removing asbestos.

Set-up Work Area — Clear area of removable furnishings and fixtures; turn off and lock-out air moving systems; cover vents, windows, walls, floors and remaining contents with plastic sheeting; provide job door with an air-lock constructed of two hanging plastic sheets; and post surrounding area with warning signs.

Provide Worker Protection — Individuals entering the work area should be fitted with disposable coveralls, goggles, gloves, and an asbestos approved respirator. If you suspect that dust concentrations will be high, only a supplied air respirator will provide the necessary protection. For lower concentrations a properly fitted, non-disposable half-face respirator with a NIOSH approved TOXIC DUST cartridge is appropriate (See Action Tips, P-1 and P-2). The work area should be monitored to determine air contaminant levels and a clean area should be provided for showering and eating. Health records; including chest x-rays, pulmonary function test and sputum cytology test results; should be established for workers.

Remove Asbestos — To minimize asbestos fiber release, spray the material lightly with a penetrating wetting agent. Repeat the spraying until the material is thoroughly moistened and will scrape off easily. Do not soak it. Before the fallen material can dry, place it in plastic bags and label the bag with a warning sign.

Clean-up — To remove all remaining fibers, damp wipe or vacuum the area. Use only a dry vacuum containing special asbestos filters. Dismantle plastic barriers, except those over vents and doorways, and clean again. Remove remaining barriers and place all plastic sheeting in labelled bags. Place all bags in 55-gallon drums and label the drums. Transport drums to authorized asbestos disposal site.

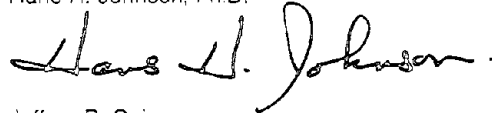
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Construction Health Hazards Prevention

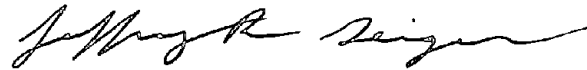
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Industrial Hygienist



SAFE ASBESTOS TREATMENT Step #4-B: Encapsulation

The application of an encapsulant is frequently an effective way of treating asbestos, particularly in the case of ceilings. Encapsulants may be divided into two classes: (1) bridging encapsulants, and (2) penetrating encapsulants. Bridging encapsulants form a continuous membrane over the asbestos. They usually do not penetrate the materials more than 1/2 inch and therefore are most effective when applied to thin and non-friable materials. In the majority of cases, you will probably want to use a penetrating encapsulant. These encapsulants penetrate greater than 1/2 inch and improve the cohesive strength of asbestos-containing products. This may also result in an improved bond between the asbestos-containing material and the underlying structure.

Ordinary paint is not an effective encapsulant. Encapsulants are highly specialized formulations exhibiting many unique properties.

ACTION TIPS

Follow these guidelines in making your choice to use an encapsulant.

- Do not use when asbestos-containing materials show signs of extensive damage, such as loose hanging or water damaged material.
- Do not use in areas that are readily accessible to wear and tear, such as low ceilings.
- Do not use if you suspect that the additional weight of the encapsulant could result in ceiling failure.

When selecting an encapsulant check the specifications closely and pick one that:

- Is non-toxic during application and will not generate toxic smoke if burned.
- Will cure to a tough, flexible, water insoluble membrane.
- Has good aging characteristics for your local climate.
- Is fire resistant and will not generate excess smoke if burned.

When applying encapsulants:

- Set up the work area as you would for asbestos removal. (See Action Tips A-12)
- Select a respirator that will protect you from both the asbestos dust and mist and vapors from the encapsulant. If you select a cartridge respirator use a combination TOXIC DUST-ORGANIC VAPOR cartridge with a PAINT PRE-FILTER.
- Provide worker protection as you would for asbestos removal. (See Action Tips A-12)
- Use the lightest spray setting possible to minimize fiber release. Several coats may be necessary.

The following partial list of manufacturers will help you select an appropriate encapsulant

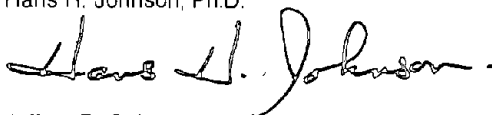
CLASSIFICATION	PRODUCT DESIGNATION	COMPANY	ADDRESS AND PHONE
Bridging	Decadex Firecheck	Pentagon Plastics U.S.A. Ltd.	7659C Fullerton Road Springfield, VA 22153 (703)569-5277
Penetrating	Cafco-Bond-Seal	United States Mineral Products Co.	Stanhope, New Jersey 07874 (201)347-1200
Penetrating	554-21-1	H. B. Fuller Co.	Foster Products Div. P. O. Box 6255 Springhouse, PA 19477 (215)628-2530 or Toll Free (800)532-6017
Penetrating	Asbestop BW25 Two Component	McGeddy International, Inc.	1043 Broadway W. Longbranch, NJ 07764 (201)229-5530
Bridging	FRC-AES	FRC Composite Ltd.	1993 Leslie Street Don Mills, Ontario M3B2XC (613)741-4243
Penetrating	Ultra Lok 40-871	Cellin Manufacturing, Inc.	P. O. Box 688 Springfield, VA 22150 (703)550-7277
Penetrating	Product #H1-6625- 583-9	Habersham Industries, Inc.	5212 Industrial Court Smyrna, GA 30080 (404)351-7173
Penetrating	350-A-1 Asbestight	Arpin Engineering, Inc.	1716 Melville Street Oakhurst, NJ 97755 (201)280-0500
Bridging	Cable Coating Z-B	American Coatings Corp.	5235 N. Elston Chicago, IL 60630 (312)286-4510
Penetrating	Mono-Therm F-100	Mono-Therm Industries, Inc.	10819-120th Ave., N.E. Kirkland, WA 98033 (800)426-2750
Penetrating	SK-13 Emulsion 360-0017	National Cellulose Corp.	12315 Robin Boulevard Houston, TX 77045 (713)433-6701

Construction Health Hazards Prevention

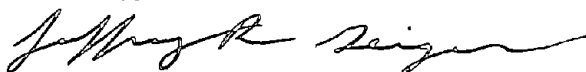
Action Tips

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Industrial Hygienist



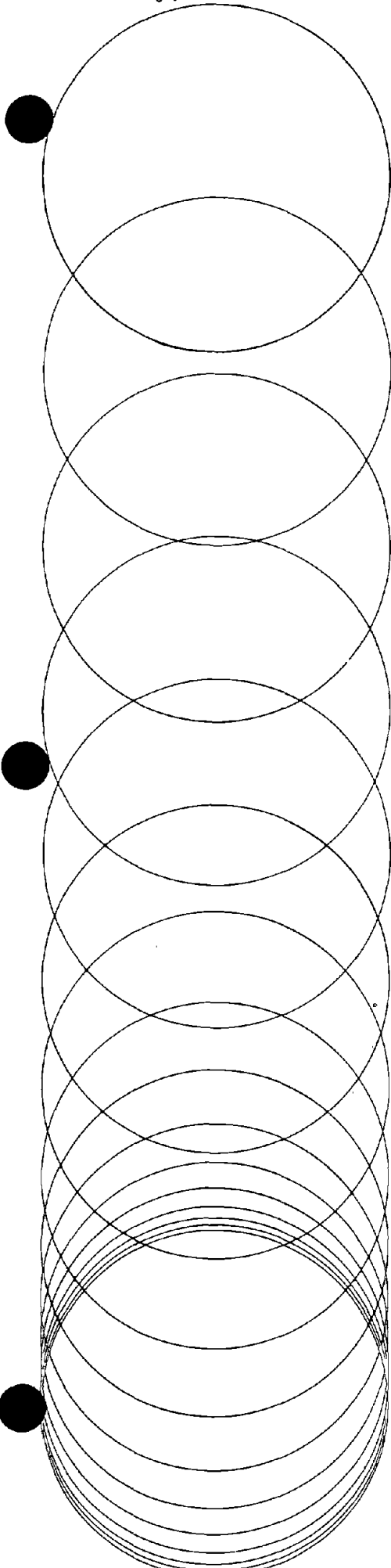
SAFE ASBESTOS TREATMENT Step #4-C: Enclosure

When deciding on how to treat asbestos-containing materials, it may be appropriate to enclose the material if it is in relatively good condition, if total enclosure of the area can be assured, and if entry to the area is not anticipated. Examples of situations where enclosing asbestos-containing materials might be appropriate would include building a box around pipes with asbestos containing lagging, refurbishing boiler insulation, and building false walls to cover walls that have been textured with asbestos-containing material.

Action Tips – Building asbestos enclosures

- If in the enclosure process asbestos fibers are likely to be released, the same steps used for removing asbestos should be followed (See Action Tips A-12).
- Pipe lagging may be enclosed by using a larger diameter fiber-glass lagging, by building wood or metal boxes around the pipe, or by securely re-wrapping with original wrapping material.
- Boiler insulation may be patched and re-wrapped.

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- Asbestos-containing textured walls may be enclosed by building false walls over them,
- All enclosures should be appropriately sealed by using caulking, moulding, tongue and groove joints, paint, and the like to prevent the escape of asbestos fibers.
- Label all enclosures with an asbestos warning sign to assure that safe work practices are carried out in the future.
- Be certain that enclosures do not connect with air plenums.
- Provide building occupant with documents clearly identifying the location and extent of all enclosed areas.

NOTE: Inform building occupant that enclosures will require routine inspection to insure that they continue to prevent asbestos exposure also maintenance activities which require entry into the enclosed area can result in the release of asbestos fibers. In this case, maintenance workers should take the necessary precautions to prevent exposing themselves to asbestos fibers and should seal off the area to prevent the release of asbestos fibers throughout the building. It will also be necessary to follow the appropriate clean-up procedures following the completion of the maintenance job. (See Action Tips A-12).

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APPENDIX H
MEDIA RELEASES





Photo for The Denver Post by Jerry Stowall

CSU EXPERT ON HAZARDS OF ASBESTOS TALKS TO SCHOOL OFFICIALS

Jeffrey Geiger speaks in schoolroom where pipe, at right, is suspect.

Louisville Middle School Making Asbestos Check

Continued from page 1.

The classroom has already been closed off and no classes will be held in it until the problem is resolved, Principal Walt Grebing said. All precautions are being taken to reduce further contamination if the material should turn out to be asbestos, he added.

The Safe Asbestos Treatment Program is the only one in the state set up to sample and test asbestos and offer advice on methods of resolving asbestos-related problems.

Welch said the county health department had taken samples of the material on the pipe a year ago but that neither the health department or the Environmental Protection Agency had facilities to test for asbestos and nothing further was done about the problem.

The Fort Collins-based asbestos program received funding in September through a grant administered by the U.S. Department of Health and Human Services to conduct studies on schools throughout the state and to provide infor-

mation about asbestos-related diseases.

TWO TYPES of cancer have been linked to exposure to asbestos. The most severe type is asbestosis, which occurs as a result of exposure to massive doses of asbestos. That form of cancer occurs almost immediately after the initial exposure to the substance. The second form of cancer linked to asbestos is rare but also quite serious.

The disease is known as mesothelioma and it occurs anywhere from 20 to 40 years after exposure to asbestos. The cancer attacks the linings of the lungs and destroys tissue completely over a period of time.

Although the use of asbestos was banned nationally in 1978, many construction contractors still use the material in combination with other insulating materials. Unre-

stricted use of asbestos in the 1960s resulted in the substance being sprayed on ceilings, wrapped around pipes and boilers and applied with trowels to walls.

According to Geiger, there are three ways to combat the potential asbestos problem in the school: cover up and reseal the hot water pipe, partition the pipe off from the rest of the room or remove the asbestos from the pipe completely. In treating an asbestos problem, extreme caution has to be taken to prevent contamination of other areas of the building from occurring, Geiger added.

School officials have indicated they will cooperate fully and undertake whatever recommendations the program members make to resolve the problem.

Louisville Middle School Making Asbestos Check

LY CHARDRA WELTY
Denver Post Staff Writer

LOUISVILLE — A potential asbestos problem has Louisville Middle School administrators in a quandry.

Safe Asbestos Treatment Program members from Colorado State University visited the school last week to take samples to determine whether material insulating a hot water pipe in a basement classroom is asbestos.

The insulating material on the pipe has been exposed ever since teacher Debbie Welch began using the room to hold fifth through eighth grade classes two years ago. Welch said fragments of the material covered the floor at the back of the classroom every night after the pipe had been bumped into or played with by students during the day.

WELCH FIRST began to

suspect the substance wrapped around the pipe might be harmful when a custodian mentioned to another teacher at the school that the pipe could have been insulated with asbestos when the school was built.

During the two years the insulation on the pipe was exposed in the room, Welch said she complained to school and district officials about the mess the crumbling material made in her classroom and asked that something be done about it. Several times, duct tape was put on the pipe to cover the exposed material, but the tape was easily damaged and came off periodically.

According to the school district's public relations director, all of the schools in the Boulder Valley district were inspected for potential asbestos problems last summer. The exposed pipe in the

basement classroom at the middle school apparently "was overlooked," she said. Jeffrey R. Geiger, one of the Safe Asbestos Treatment Program experts, told school and district officials that the substance must first be tested and analyzed and an air sample taken and analyzed to determine whether or not the school has an asbestos problem.

Geiger said the presence of asbestos isn't in itself a problem, but that a problem does exist if large amounts of minute asbestos fibers are released into the air due to damage to the asbestos.

RESULTS OF THE samples taken at the school will be available this week, Geiger said. In the meantime, the program members will assist school and district personnel in making a decision regarding the potential asbestos problem.

Continued on page 2.

Photo for The Denver Post by Jerry Stowart

SAMPLE OF SUSPECTED ASBESTOS TAKEN

Jeffrey Geiger, member CSU asbestos team, takes sample in a basement classroom at Louisville Middle School.

Asbestos research in school areas

To The Denver Post:

THE ARTICLE in the Nov. 12 edition concerning the asbestos check in the Louisville (Colo.) Middle School was timely and objective. However, several items require clarification.

While there are several types of cancer linked to asbestos exposure, asbestosis is not one of them. Asbestosis is a non-malignant fibrotic lung disease that usually occurs after many years of moderate- to high-level asbestos exposure. The types of cancer currently linked to asbestos exposure are lung cancer, mesothelioma and tumors of the digestive tract.

The primary concern in regard to school is that these cancers, especially mesothelioma, can be induced by relatively low-level exposures. They typically require 20-40 year post-exposure to develop, which is well within the life-expectancy of a schoolchild.

I would also like to stress that the use of asbestos has not been banned nationally. Certain uses, such as sprayed-on asbestos coatings, have been curtailed; but asbestos use continues in commercial drywall products, wallboard, pipe, floor tile and many other products.

The inherent complexity of the school asbestos issue was a major factor in the establishment of the Colorado State University Safe Asbestos Treatment Program. Through research and the dissemination of information, we seek to provide Coloradans with the resources necessary to deal both rationally and effectively with asbestos in schools.

JEFFREY R. GEIGER

Industrial Hygienist

Safe Asbestos Treatment Program

Colorado State University

Fort Collins

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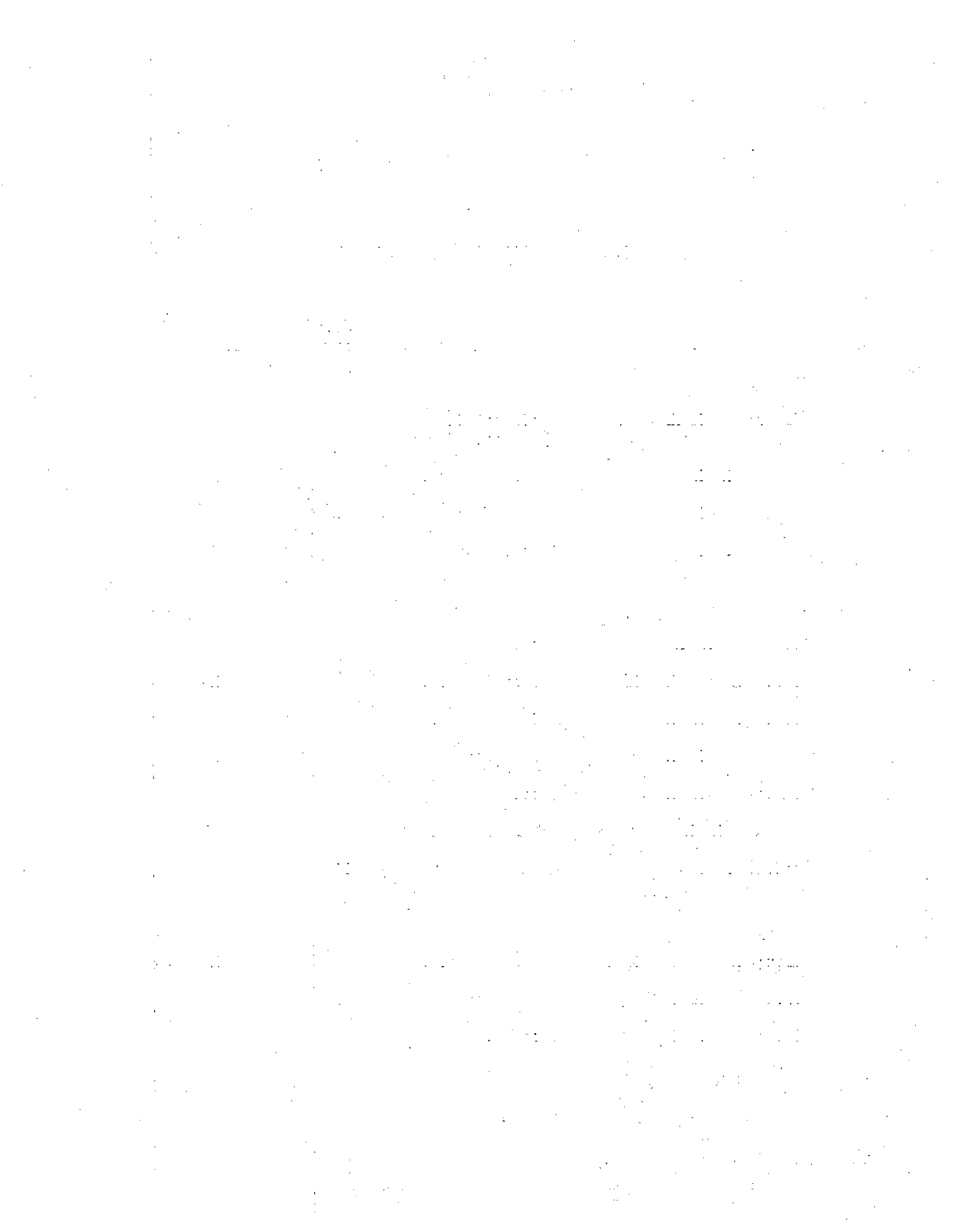
APPENDIX I

BUILDING SURVEY BY SCHOOL DISTRICT

APPENDIX I

BUILDING SURVEYS BY SCHOOL DISTRICTS

<u>Dates</u>	<u>School District</u>	<u>Number of Facilities Surveyed</u>	<u>Number of Bulk Samples</u>
<u>PILOT SCHOOLS</u>			
October 25, 1981	Boulder Valley (Louisville)	9	6
December 1, 1980	Montezuma-Cortez	6	14
December 3, 1980	Monte Vista	5	6
December 5, 1980	Florence	4	6
<u>STUDY POPULATION SCHOOLS</u>			
January 8, 1981	Aurora	9	30
January 12 and 14, 1981	Montrose County	6	14
January 13, 1981	Dolores County	3	8
January 20, 1981	East Otero	7	16
January 22, 1981	Harrison	3	7
March 26, 1981	East Yuma County	4	11
April 1, 1981	Denver	13	27
<u>OTHER SCHOOLS</u>			
January 12 and 14, 1981	Montrose County	9	19
January 20, 1981	East Otero	1	2
January 22, 1981	Harrison	2	4



APPENDIX J

DATA COLLECTION FORMS
("SAMPLE COLLECTION DATA" AND
"AN EVALUATION AID IN ASSESSING POTENTIAL ASBESTOS EXPOSURE")

SAMPLE COLLECTION DATA

SCHOOL DISTRICT _____ DATE _____

SCHOOL _____

TYPE OF ROOM/AREA _____

DATE OF CONSTRUCTION _____

() original () add-on () remodel

SAMPLE ID# _____

DESCRIPTION _____

LOCATION _____

ACTIVITY _____
ACCESSIBILITY _____
CONDITION _____
FRIABILITY _____
VENTILATION _____
% ASBESTOS _____

TOTAL

SAMPLE ID# _____

DESCRIPTION _____

LOCATION _____

ACTIVITY _____
ACCESSIBILITY _____
CONDITION _____
FRIABILITY _____
VENTILATION _____
% ASBESTOS _____

TOTAL

NOTES



AN EVALUATION AID IN ASSESSING POTENTIAL
ASBESTOS EXPOSURE

NOTE OF CAUTION: This evaluation aid is presented to provide general guidance. If there is any question regarding the potential for asbestos exposure of students and other building users, professional consultation is necessary.

Directions for use:

1. For each of the six factors, circle the most appropriate numerical value (circle only one number per factor) or record on the "Sample Collection Data" form.
2. Add up all of the circled numbers, and refer to the "Action Suggestions."

Note: the minimum total value is six (6) and the maximum total value is nineteen (19).

ACTIVITY

The potential, because of room use, for damage to asbestos containing material.

Numerical
Value

Evaluation Category

1	Low activity areas (e.g., closets and storage rooms; conference rooms; faculty room; administration offices; nurse's office; janitor's room; boiler room)
2	Moderate activity areas (e.g., locker room; music room; cooking, sewing and typing rooms; science rooms; shops; general classrooms; kitchen)
3	High activity areas (e.g., gymnasium; auditorium, cafeteria, hallways and stairways; swimming pool, all purpose rooms)

EVALUATION OF POTENTIAL ASBESTOS EXPOSURE - 2

ACCESSIBILITY The relative ease with which the asbestos-containing material may be reached or disturbed.

Numerical Value	Evaluation Category
1	Totally enclosed, encapsulated or tightly bound (e.g., pipe lagging behind enclosed radiators; floor tiles unless scored or sanded)
2	Generally inaccessible to school population (e.g., ceiling tiles and sprayed surfaces beyond normal hand reach or potential damage from thrown objects; pipe lagging in locked closet)
3	Accessible (e.g., pipe lagging, ceiling surfaces, etc., within hand reach or subject to damage from thrown objects-gymnasium, hallway, classroom ceilings)

CONDITION The degree of deterioration and damage of asbestos-containing materials.

Numerical Value	Evaluation Category
1	No damage at all.
2	Slight to moderate damage (e.g., small chips missing from ceiling tiles; mild water stains on ceilings; loose pipe wrapping)
3	Severe damage (e.g., scored or punctured pipe lagging, loosely hanging material, severe water damage)

EVALUATION OF POTENTIAL ASBESTOS EXPOSURE - 3.

FRIABILITY

The ease with which the asbestos-containing material may be broken or crumbled.

<u>Numerical Value</u>	<u>Evaluation Category</u>
1	Nonfriable (i.e., asbestos fibers firmly bound as in some floor tiles and pipes; material cannot be broken or fractured with hands)
2	Moderately friable (i.e., material may be broken or fractured, but breaks up into relatively large pieces)
3	Very friable (i.e., material is easily broken apart with hands and easily crumbled with fingers)

AIR MOVEMENT

The degree to which asbestos fibers may accumulate in the area of the sampling site.

<u>Numerical Value</u>	<u>Evaluation Category</u>
1	Presence of mechanical air moving system which exhausts air to building exterior
2	Limited air movement (i.e., open doors and windows, ceiling fan)
3	Essentially no air movement

EVALUATION OF POTENTIAL ASBESTOS EXPOSURE - 4

PERCENT ASBESTOS

The amount of asbestos contained in the material. (NOTE: This will be indicated on the laboratory analysis report.)

Numerical Value	Evaluation Category
1	One to 10 percent
2	Eleven to 25 percent
3	Twenty-six to 50 percent
4	Fifty-one percent or more

Total numerical value (add up the circled numbers)

ACTION SUGGESTIONS:

In general, the lower the total numerical value that results from the above assessment, the lower is the risk that exposure to asbestos fibers may occur. Likewise, higher values represent higher exposure potentials. There are four ways of dealing with asbestos-containing materials: management, enclosure, encapsulation and removal. This exposure potential value should be used together with expert advice to determine what action is appropriate in each situation.

APPENDIX K

DATA COLLECTION FORMS ("GENERAL DATA")

GENERAL DATA

Date _____

ADDRESS

School Name _____

District _____

Address _____

GRADE LEVELS SERVED _____

SCHOOL POPULATION

Number of pupils _____

Number of teachers and staff - full-time _____

part-time _____

BUILDING USE

A. Standard Curricular Use (regular classes)

-Days per year _____

-Teacher and staff attendance hours per day _____

-Pupil attendance hours per day _____

B. Extracurricular Use (teacher/staff supervised)

-Days per year _____

-Supervisor attendance hours per day _____

-Pupil attendance hours per day _____

C. Community and Other Use

-Days per year _____

-Hours per day _____

-Number of people _____

BUILDING CONSTRUCTION

A. Original construction

-Date(s) _____

-Contractor _____
(name and address)



GENERAL DATA - 2

A. Original construction (continued)

-Architect _____
(company name)

(address)

-Description _____

B. Additions

1. -Date(s) _____

-Contractor _____
(company name)

(address)

-Architect _____
(company name)

(address)

-Description _____

2. -Date(s) _____

-Contractor _____
(company name)

(address)

-Architect _____
(company name)

(address)

-Description _____

GENERAL DATA - 3

D. Remodelling

1. -Date(s) _____

-Contractor _____
(company name)

(address)

-Architect _____
(company name)

(address)

-Description _____

2. -Date(s) _____

-Contractor _____
(company name)

(address)

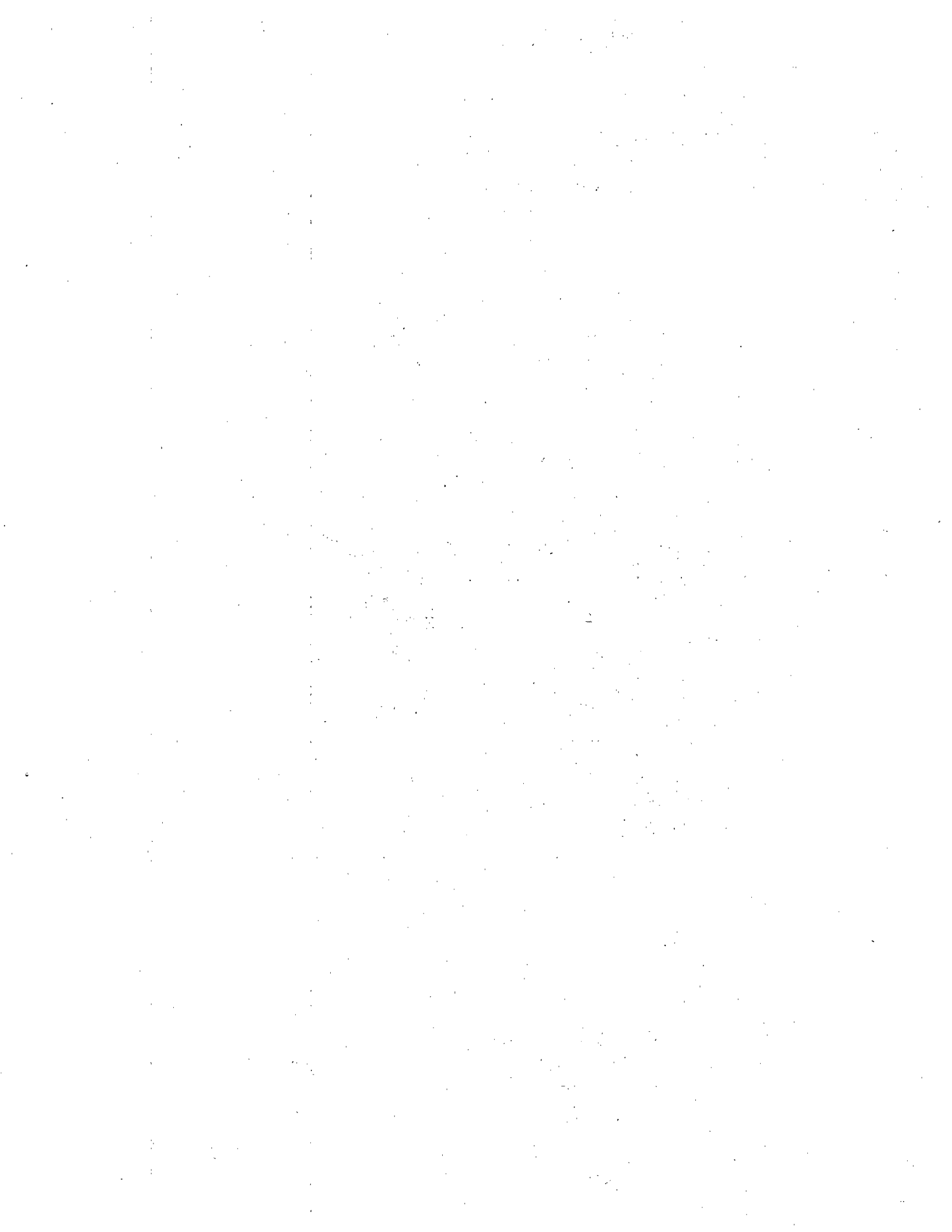
-Architect _____
(company name)

(address)

-Description _____

APPENDIX L

K² ASBESTOS SCREENING TEST



K² ASBESTOS SCREENING TEST

A. MAGNESIUM TEST

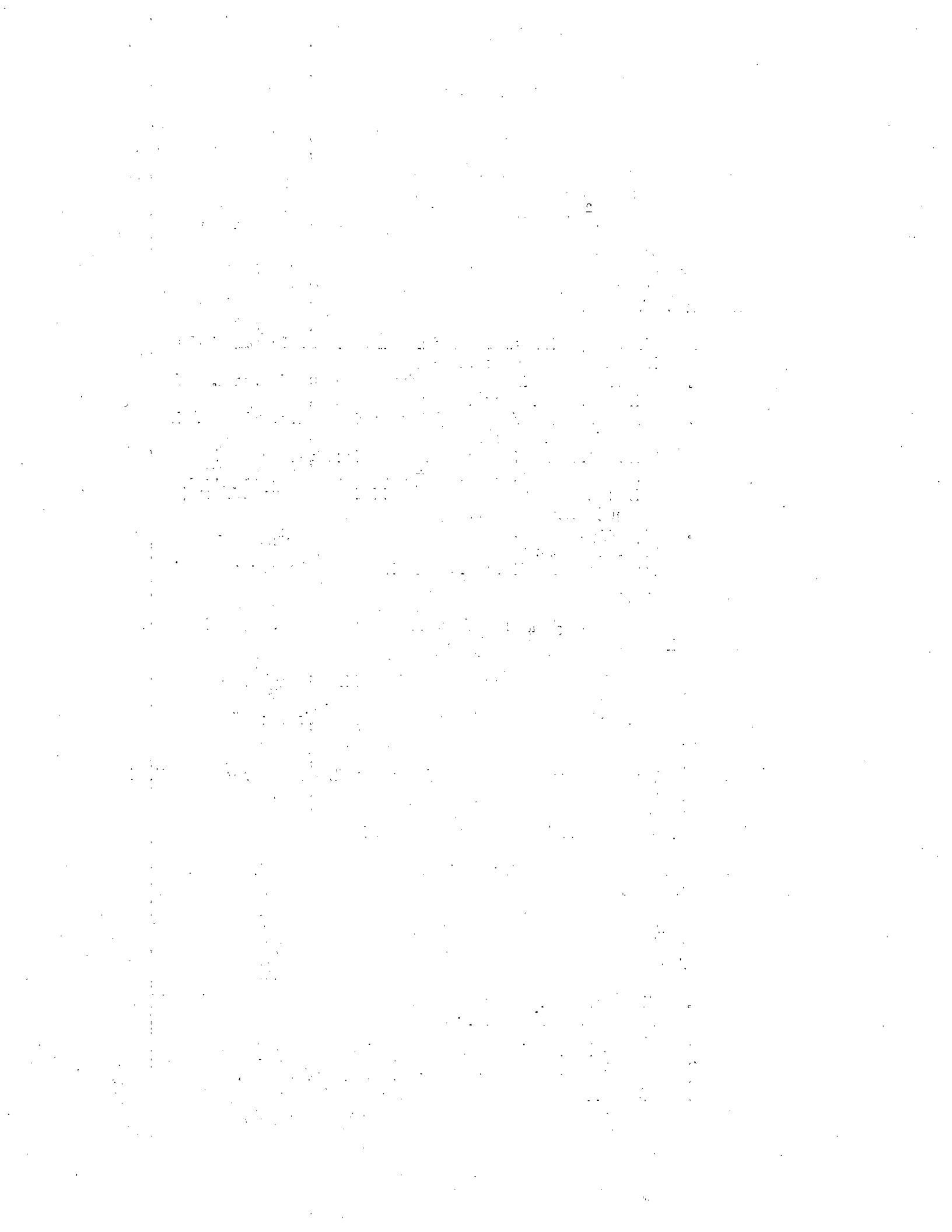
1. Glycerin wash

- a. Place a small portion of sample, about the size of a large pea, in a mortar.
 - b. Crush the sample and add five drops of glycerin. Mix well with a plastic rod or spatula.
 - c. Rinse the plastic rod with a small amount of distilled water into the mortar.
 - d. Filter the sample through the filtration assembly consisting of a syringe attached to a Swinnex filter holder loaded with a mixed cellulose ester filter (25 mm, 0.8 μ m) and a gasket.
 - e. Filter with a minimum of five washings or about 50 mL of distilled water.
 - f. Transfer the filter to a Teflon dish for the magnesium test.
2. Add a drop of H₃PO₄ and mix well by grinding the sample with a plastic rod.
 3. Add two drops of 10 N NaOH and mix well.
 4. Add five drops of magnesium reagent and stir briefly. Note any color change.
 5. Add five more drops of magnesium reagent and observe the final color.
 6. A blue color indicates that chrysotile may be present.
 7. If the magnesium test is negative, the sample must be tested for iron.

B. IRON TEST

1. Acid wash

- a. Place a small portion of the sample, about the size of a large pea, in a mortar.
- b. Crush the sample.
- c. Add five drops of concentrated acetic acid.
- d. Add five drops of concentrated sulfuric acid.
- e. Mix well



- f. Filter the sample through a polyvinyl chloride filter (25 mm) with a minimum of five washings or about 50 mL of distilled water.
 - g. Transfer the filter to a Teflon dish and proceed with the iron test.
2. Add a drop of HF solution and mix well.
 3. Add five drops of iron reagent and observe the development of red color.
 4. The red color indicates that amosite or crocidolite may be present.

APPENDIX M

PERCENT ASBESTOS IN BULK SAMPLES, AMOUNT OF DAMAGE TO MATERIALS,
AND ACTIVITY LEVELS BY SAMPLING DAY FOR COLORADO PUBLIC SCHOOL
FACILITIES, WINTER AND SPRING 1981

FACILITY	% ASBESTOS BULK SAMPLE	DAMAGE TO MATERIAL	SAMPLING DAY	ACTIVITY LEVEL
1	lobby 2-5%	gymnasium: severe	1	high
	north corridor 1-2%	central corridor: severe		
	central corridor 15 (± 5)%	all other: moderate		
2	cafeteria 1-2%	slight	1	moderate
3	gymnasium 2-5%	gymnasium: moderate	1 Set 1	low
			Set 2	high
4	central corridor 5-10%	multipurpose room: severe	1	moderate
		hallways: severe	2	low
		classrooms: slight to moderate		
5	Level 1 1-4%	in air plenum	1	moderate
	Level 4 1-6%		2	Level 2: moderate
	Level 6 1-3%			all other: low
6	hallway 1st floor 5%	hallway 1st floor: moderate	1	low
	auditorium 8%	auditorium: slight	2	low
	hallway 2nd floor 11%	boys' room 2nd floor: severe		
	art room 10%	art room: severe		
	gymnasium 3-5%	gymnasium: severe		
	new addition 10%	new addition: in air plenum		



FILTER COUNTS, FILTER COUNTS MINUS THE BLANK MEAN COUNT, AND CONCENTRATIONS (f/cc) DERIVED FROM SEM ANALYSIS FOR SIX COLORADO PUBLIC SCHOOL FACILITIES, WINTER AND SPRING 1981

FACILITY	SAMPLING DAY	TOTAL FIBERS	TOTAL FIBERS MINUS X BLANK	CONCENTRATION* (f/cc)
1	1	84,000	27,000	0.008
2	1	58,000	1,000	<report**
3	1 Set 4	110,000	54,000	0.009
	1 Set 2	63,000	54,000	0.009
4	1	221,000	164,000	0.059
		110,000	53,000	0.017
		53,000	Less than blank	<detect***
5	1	41,000	Less than blank	<detect
		64,000	7,000	0.002
		79,000	22,000	0.005
		114,000	57,000	0.013
6	1	59,000	2,000	<report
	2	58,000	1,000	<report
		21,000	Less than blank	<detect

*Concentration based on Total Fibers Minus X Blank.
 **Less than reportable = less than a thousandths of a f/cc.
 ***Less than detectable.



FILTER COUNTS, FILTER COUNTS MINUS THE BLANK MEAN COUNT, AND CONCENTRATIONS (ASBESTOS f/cc)
 DERIVED FROM TEM ANALYSIS FOR FIVE COLORADO PUBLIC SCHOOL FACILITIES, WINTER AND SPRING 1981

FACILITY	SAMPLING DAY	LOCATION	TOTAL ASBESTOS FIBERS	TOTAL ASBESTOS FIBERS MINUS \bar{X} BLANK	CONCENTRATION* (ASBESTOS f/cc)
1	1	Inside	488,000	471,000	0.143
		Inside	198,000	181,000	0.048
3	1	Outside	90,000	73,000	0.012
		Inside	148,000	131,000	0.021
4	1	Inside	2,546,000	2,529,000	0.298
		Outside	288,000	271,000	0.050
5	1	Inside	212,000	195,000	0.061
		Outside	2,207,000	2,190,000	0.782
6	2	Inside	138,000	121,000	0.043
		Outside	37,000	20,000	0.004
6	2	Inside	43,000	26,000	0.006
		Outside	34,000	17,000	0.004
6	2	Inside	49,000	32,000	0.007
		Outside	22,000	5,000	0.001

*Concentration based on Total Asbestos Fibers Minus \bar{X} Blank.



APPENDIX N

ASBESTOS RESOURCE MATERIALS



PUBLICATIONS

1. Asbestos Containing Materials in School Building: A Guidance Document, Parts 1 and 2. 1971. Booklets.
Avail: Environmental Protection Agency, 1860 Lincoln Street, Denver, CO 80295.
Telephone: (303) 837-3926.
2. Asbestos Disease - Are You Covered? K. W. Carlson; R. A. Fowler. Brochure.
Avail: Western Institute for Occupational/Environmental Sciences, Inc.;
2001 Dwight Way, Berkeley, CA. 94704
Telephone: (415) 845-6476.
3. Asbestos Exposure: A Desk Reference for Communicators. May 1978. Booklet:
Order No. NIH-79-1622.
Avail: National Cancer Institute, Office of Cancer Communication, Bldg. 31,
Rm. 10A18, 9000 Rockville Pike, Bethesda, MD 20205.
Telephone: (301) 496-5583
4. Asbestos Exposure: What It Means, What To Do. 1978. Brochure: Order No.
NIH-79-1566.
Avail: National Cancer Institute, Office of Cancer Communications, Bldg. 31,
Rm. 10A18, 9000 Rockville Pike, Bethesda, MD 20205.
Telephone: (301) 496-5583.
5. Cancer Information in the Workplace: Annotated Bibliography of Educational
Materials for the Public and Health Professionals. May 1979. Booklet: Order
No. NIH-79-2001.
Avail: National Cancer Institute, Office of Cancer Communications, Bldg. 31,
Rm. 10A18, 9000 Rockville Pike, Bethesda, MD 20205.
Telephone: (301) 496-5583.
6. Carcinogens: Regulation and Control. 1977. Brochure: Order No. NIOSH-77-205.
Avail: National Institute for Occupational Safety and Health, Publications
Office, 4676 Columbia Parkway, Cincinnati, OH 45226.
Telephone: (513) 684-4287.
7. Health Hazards of Asbestos: Series: Cancer Alert. George Washington Univer-
sity Medical Center, Science Communication Division. 1979. Brochure: Order
No. OSHA-3040.
Avail: U.S. Department of Labor, Occupational Safety and Health Administration,
Office of Publications, RM. N-3423, 200 Constitution Ave., N.W.,
Washington, D.C. 20201.
Telephone: (202) 523-6138.



8. OSHA: Your Workplace Rights in Action. 1978. Brochure: Order No. OSHA-3032.
Avail: U.S. Department of Labor, Occupational Safety and Health Administration,
Office of Publications, Rm. N-3423, 200 Constitution Ave., N.W.,
Washington, D.C. 20201.
Telephone: (202) 523-6138
9. What You Need to Know About Cancer. 1979. Brochure: Order No. NIH-79-1566.
Avail: National Cancer Institute, Office of Cancer Communications, Bldg. 31,
Rm. 10A18, 9000 Rockville Pike, Bethesda, MD 20205.
Telephone: (301) 496-5583.
10. The Asbestos Hazard. P. Brodeur. 1980. Book.
Avail: The New York Academy of Sciences, 2 East 63rd Street, New York, NY 10021.
11. Update on Asbestos. A. Labbauf. 1980. Booklet.
Avail: Penn Environmental Health, 6938 Meade Street, Pittsburgh, PA 15208
12. Asbestos Dust: Everyone's Problem. R. A. Fowler. Booklet.
Avail: Western Institute for Occupational/Environmental Sciences, Inc., 2001
Dwight Way, Berkeley, CA 94704.
Telephone: (415) 845-6476.
13. Plan Talk About Asbestos. R. A. Fowler; P. L. Polakoff. 1978. Booklet.
Avail: Western Institute for Occupational/Environmental Science, Inc., 2001
Dwight Way, Berkeley, CA 94704.
Telephone: (415) 845-6476.
14. Asbestos: The Need for and Feasibility of Air Pollution Controls. 1971.
Booklet.
Avail: National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington,
D.C. 20418.
15. Asbestos: An Information Resource. 1978. Booklet: Order No. NIH-79-1681.
Avail: National Cancer Institute, Office of Cancer Communications, Bldg. 31,
Rm 10A18, 9000 Rockville Pike, Bethesda, MD 20205.
Telephone: (301) 496-5582.

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