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CURRENT AND POTENTIAL ASBESTOS HAZARD ASSESSMENTS: EFFECTS OF INSPECTORS' TRAINING AND PROFESSIONAL BACKGROUND

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ABSTRACT

Federal legislation has created a structure for the inspection and assessment of asbestos in schools and commercial buildings. Unlike other air pollution programs, these assessments are based on visual inspections by certified inspectors rather than more objective air monitoring data. Considering the multi-billion dollar abatement expenditures that have been made based upon these inspections, little information presently exists to indicate the level of consistency of damage estimates made by certified inspectors.

This article reports on an analysis of the consistency of asbestos damage assessments using a sample of 250 novice and experienced certified inspectors taking inspection courses at University of Illinois Midwest Training Center. The analysis sought to determine the level of consistency of damage estimates and the effects of experience and professional background on the assessments of current and potential damage of asbestos material in a variety of settings.

INTRODUCTION

In 1986 Congress passed the Asbestos Hazard Emergency Response Act (AHERA) which required that thousands of schools in the United States be inspected for asbestos. Schools were required to develop asbestos management

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plans based upon such inspections. This legislation spawned a multi-billion-dollar industry, intensive inspection and asbestos abatement activity, as well as the training and certification of thousands of asbestos inspectors, contractors, and workers.

Unlike traditional air quality approaches developed for the control of pollutants, the assessment of the hazards posed by airborne asbestos in schools was a far more subjective process. One of the more controversial aspects of AHERA was that air sampling not be the primary method used to estimate exposures. Instead, AHERA relies upon visual inspection by certified inspectors to determine both the extent of existing damage of asbestos material and the potential for future damage based upon such factors as the accessibility of the asbestos material, the presence of vibration sources near the material, and the traffic in the area surrounding the asbestos. Since inspector judgments are central to the asbestos hazard analysis, the quality of the training of inspectors plays a key role in the implementation of AHERA. AHERA specified the training and certification requirements for inspectors based upon taking a set of short courses. No prior experience or prior professional accreditation (e.g., certified industrial hygiene, professional engineer) was required to obtain asbestos inspector or contractor certification.

In 1990, Congress passed further legislation (the Asbestos School Hazards Abatement Reauthorization Act—ASHARA) which extended many of the provisions of AHERA to public and commercial buildings. ASHARA mandates that, as of April 1994, any asbestos inspection, design, or abatement work done in public or commercial buildings would have to be done by accredited individuals. It is likely that ASHARA will induce further significant asbestos training, inspection, and abatement activity over many years into the future.

Despite the level of past inspection activity based on AHERA and the potential for future activity induced by ASHARA, very little information presently exists regarding the quality and consistency of the asbestos inspectors' judgments, nor does either legislation require an evaluation of inspector performance.

The dependence of decisions involving significant investments in asbestos removal by schools and commercial building owners based upon subjective judgments made by inspectors certified in this way, has raised issues regarding the consistency and validity of such judgments and the soundness of present training approaches [1-3]. This article reports on an analysis of the consistency of inspector judgments made by novice and experienced inspectors taking certification and recertification asbestos short courses at the University of Illinois Midwest Training Center.

Design of the Assessment of Inspection Decisions

The study involved 250 asbestos professionals who took certification or recertification courses at the Center. Based upon the AHERA regulatory guidelines, inspectors are called upon to classify asbestos material in one of three categories—not damaged, damaged, or significantly damaged. In addition the material must be judged according to its potential for future damage—no potential damage, potential damage, or risk of significant potential damage. Potential damage is judged based upon the presence or absence of disturbance factors (e.g., nearby sources of vibration). The training courses attempt to provide guidelines to make such decisions on asbestos found in surfacing materials, asbestos used as thermal insulation and "miscellaneous" asbestos applications.

The specific questions that this study sought to answer were four:

1. When asbestos professionals are shown identical asbestos material conditions, what variance exists in judgments regarding its condition?
2. Does the level of experience of the professional have any effect on the assessment of current or potential damage?
3. Does the occupational background of the professional have any effect on the damage assessments?
4. Is the judgment regarding the potential damage of the material distinct from the assessment of its present condition? (Are these assessments truly independent judgments?)

To evaluate the consistency in performing condition assessments, the ideal method would be to record the professionals' judgments as they inspected a number of buildings. Given the variety of asbestos applications and conditions to be inspected and the time constraints posed by course schedules at the Center, an alternative approach was employed. To simulate the condition assessment process, a workbook was developed that contained photographs and written information on asbestos in fifteen different areas in three hypothetical schools. Figure 1a reproduces the workbook material for one such area.

Participating individuals were asked to respond to questions on the nature and extent of current damage to the asbestos after viewing the photographs and reading the descriptions. Rather than simply rating the material by the three levels of condition, they were asked to also rate their confidence in their assessment (Figure 1b). The participants had 10 points to distribute to express their confidence in their assessment. A score of 0 signals no confidence while a score of 10 indicated certainty regarding the material's condition. For example, if there was no doubt that an area was significantly damaged, the participant could assign all 10 points to that condition. For material that appeared to be in a borderline condition, points could be assigned to more than one condition as long as the sum of points was 10 (see Figure 1b). The same procedures were employed for answering questions on the potential for damage.

Seven examples of asbestos used in thermal systems were employed in the workbook. Five workbook examples were of asbestos in surfacing materials while three miscellaneous uses of asbestos were presented to the participants. Thus, 3750 inspection judgments were simulated (15 examples $\times$ 250 participants).

HOMOGENEOUS AREA DESCRIPTION & WORKSHEET [Page 1 of 2] RESPONDENT # ________

SCHOOL E HOMOGENEOUS AREA # 1 -- PIPE COVERING

FUNCTIONAL AREA BOILER ROOM

1. TYPE OF MATERIAL AND APPLICATION:

SURFACING MATERIAL	THERMAL SYSTEM	MISC.	APPLICATION
[ ]-Fireproofing	[X]-Pipe	[ ]-Ceiling tile	[ ]-Sprayed
[ ]-Sound proofing	[ ]-Duct	[ ]-Floor tile	[ ]-Troweled
[ ]-Acoustic plaster	[ ]-Tank		[X]-Pre-formed
[ ]-Hard plaster	[ ]-Boiler		[ ]-Other

2. DISTURBANCE FACTORS:

CONTACT POTENTIAL ACM IN WORK AREA

PRESENCE OF VIBRATION SOURCES OPERATING MACHINERY

PRESENCE OF AIR HANDLING EQUIPMENT NONE NOTED

PROXIMITY TO EQUIPMENT REQUIRING PERIODIC MAINTENANCE NEAR PLUMBING

OCCUPANCY MAINTENANCE

BARRIERS PRESENT NONE NOTED

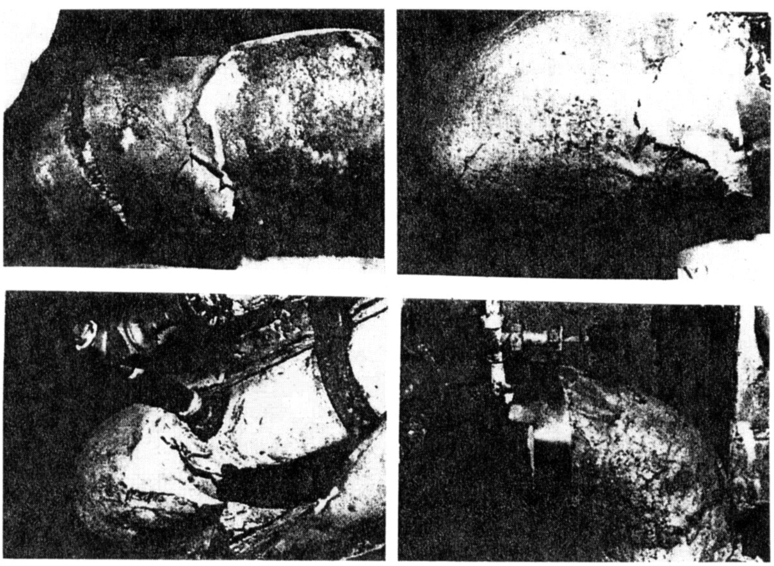

Figure 1a.

HOMOGENEOUS AREA DESCRIPTION & WORKSHEET [Page 2 of 2] RESPONDENT # ________

SCHOOL E HOMOGENEOUS AREA # 1 -- PIPE COVERING

FUNCTIONAL AREA BOILER ROOM

3. CURRENT CONDITION:

TYPE OF DAMAGE	EXTENT OF DAMAGE	AMOUNT OF AREA DAMAGED
[ ]-Deterioration [ ]-Water [ ]-Physical	[ ]-Localized [ ]-Distributed	[ ]-None (0%-Area) [ ]-Less than 10% Area [ ]-10 to 25% Area [ ]-More than 25% Area

RATING YOUR CONFIDENCE IN THE THREE AHERA TYPES OF "CURRENT CONDITIONS:"

Assign a total of 10-Points across the 3 AHERA "Current Conditions:" Give the most points to the conditions having your greatest confidence. If you are equally confident that either of 2 conditions could be named, (e.g., DAMAGED or SIGNIFICANTLY DAMAGED), then assign 5 points to each and 0 to the No Damage condition. The sum of the 3 ratings must equal 10.

CURRENT CONDITION	Circle Confidence for each of the 3 conditions, Sum must = 10
NO DAMAGE	LEAST 0 1 2 3 4 5 6 7 8 9 10 MOST
DAMAGED	LEAST 0 1 2 3 4 5 6 7 8 9 10 MOST
SIGNIFICANT DAMAGE	LEAST 0 1 2 3 4 5 6 7 8 9 10 MOST

DOES THE SUM OF THE 3 CURRENT CONDITION RATINGS = 10?

4. DISTURBANCE FACTOR

ACCESSIBILITY	VIBRATION	AIR MOVEMENT	ACTIVITY/USE OF AREA
[ ]-Inaccessible [ ]-Barely Accessible [ ]-Easily reached	[ ]-None [ ]-Low [ ]-Moderate [ ]-High	[ ]-Low [ ]-Moderate [ ]-High	[ ]-Low [ ]-Moderate [ ]-High

RATE "DAMAGE-POTENTIAL" WITH 10-POINT TOTAL ACROSS 3-POTENTIAL CONDITIONS

POTENTIAL CONDITION	Circle Confidence for each of the 3 conditions, Sum must = 10
NO DAMAGE	LEAST 0 1 2 3 4 5 6 7 8 9 10 MOST
DAMAGED	LEAST 0 1 2 3 4 5 6 7 8 9 10 MOST
SIGNIFICANT DAMAGE	LEAST 0 1 2 3 4 5 6 7 8 9 10 MOST

DOES THE SUM OF THE 3 POTENTIAL CONDITION RATINGS = 10?

Figure 1b.

Information was also gathered from the participants regarding their professional background and level of experience.

SURVEY RESULTS

In order to develop measures for the consistency of inspector judgments, the numerical point allocations for each of the fifteen areas judged in the survey were recoded in order to determine which condition category would have been chosen by each participant. For example, if a participant assigned 7 points to the damaged category and 3 to undamaged, the material was considered to be judged as damaged. The percentage of participants choosing each current condition for each area was then tabulated. Figure 2 shows the results of the tabulation.

The relatively low percentage of agreement across all fifteen sites by the participants is evident. On average, only about 60 percent of the participants could agree on the condition of a given site. The economic implication of this low level of consistency in judgment (if the finding held true in actual field conditions) are sizable. EPA guidance documents advise that in areas which are judged to be significantly damaged the asbestos material should be removed immediately. The past costs to schools and future costs to public and commercial buildings of such removal actions are significant. Research by Croke et al. suggests that removing asbestos from the nation's schools and private buildings will cost about ten billion dollars or approximately 3 percent of the total value of the buildings [4].

In order to determine differences in judgments by occupation or level of experience, the judgments of each participant was converted to a single continuous variable—a hazard ranking index.

$$\text{HRI} = [(\text{No damage score} * 0) + (\text{Damage score} * .5) + (\text{Significant damage score} * 1.0)]/10$$

Thus, the HRI was normalized within a scale of 0.0 to 1.0 where 0 represents a judgment made with certainty that no hazard exists and 1.0 is a judgment of maximum hazard based upon the inspector's certainty that the material is significantly damaged. The index was calculated for each of the fifteen areas for existing and potential damage judgments for each inspector. The transformed data were then analyzed for the significance of the differences in means, between different sub-groups of participants using analysis of variance techniques.

Figure 3 presents the average current hazard scores for experienced and inexperienced inspectors for each of fifteen sites. Experienced inspectors were defined to be those with one or more years of building inspection experience that were taking recertification courses. Trainees had completed the basic inspection course. Figure 4 presents the average potential hazard scores for these two groups. Scores range from .89 to .17. Asterisks indicate significant differences in scores between the two groups at the .05 and .1 levels.

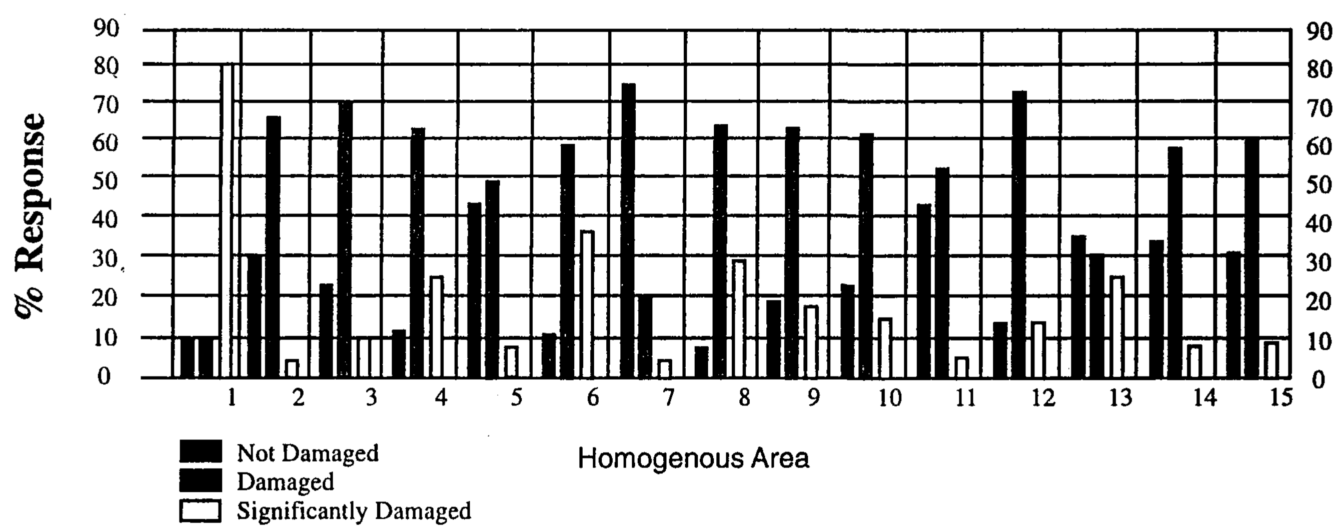

Figure 2. Current condition.

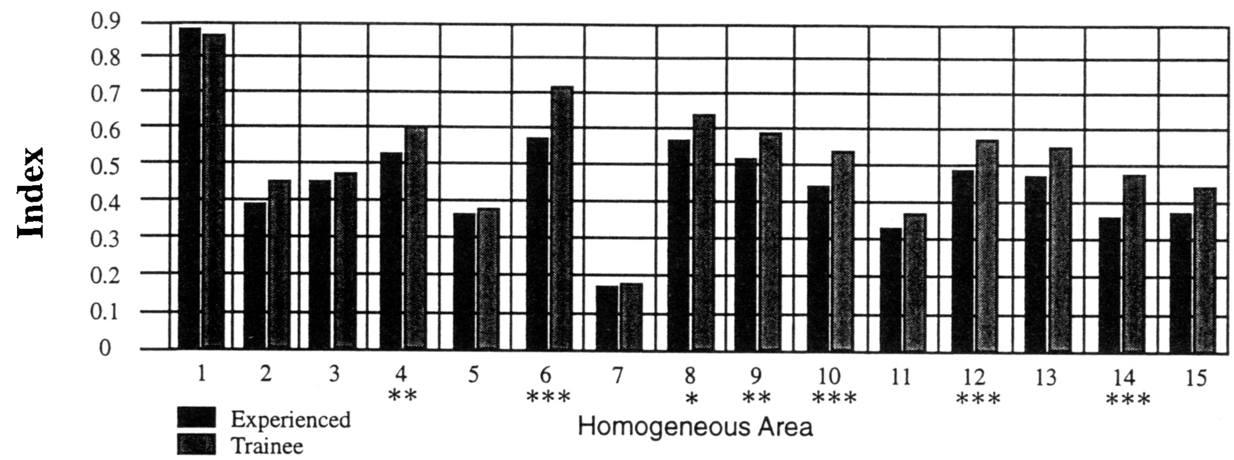

Figure 3. Judgments of experienced inspectors and trainees:
Current conditions.

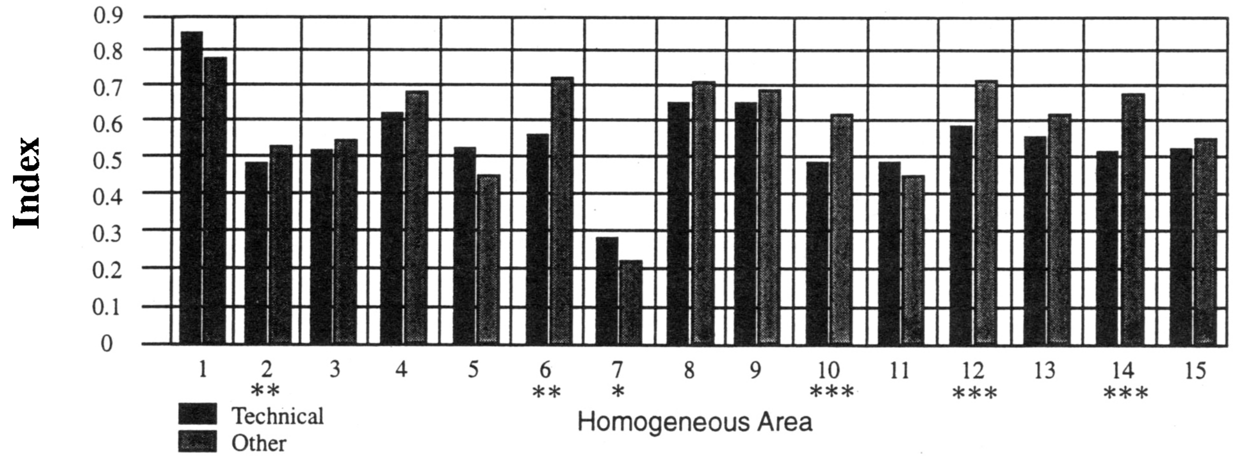

Figure 4. Judgment of experienced inspectors and trainees:
Potential hazard conditions.

In seven of the fifteen areas judged, trainees current hazard scores were statistically significantly higher than experienced inspectors at the .05 or .1 level. In all but one case, trainees average current scores were higher, indicating a judgment of greater damage, than the experienced inspectors. Examination of potential hazard scores show a similar pattern with six of the fifteen cases showing significantly different scores at the .05 or .1 level. In eleven of the fifteen cases, trainee potential hazard scores were higher than experienced inspectors' scores. The variances of the experienced inspectors scores were lower than that of trainees for nine of the fifteen areas for the current assessments but, surprisingly, were higher than trainees in all fifteen cases for the potential hazard scores.

Figure 5 presents the average current hazard scores of participants with technical backgrounds compared to an "other" category. Individuals with technical backgrounds were defined to be architects, environmental specialists, occupational health specialist or engineers. Significant differences in the means were found in only one of the fifteen cases. Figure 6 presents the average potential hazard scores for the two groups. Again in only one case are the means of the potential hazard scores significantly different between participants with technical backgrounds and "others."

A comparison of average current and potential hazard scores for any of the sub-groups examined reveals a pattern in which the judgment of current condition appears to be used as an "anchor" to assess potential hazard. A correlation coefficient of 0.953 was computed between the current and potential hazard scores using all participant scores. In all but one of the fifteen areas, the potential hazard score is higher than the current score. A number of regression models were tested. A non-linear relationship of the following form:

$$\frac{\text{Potential Hazard Score}}{\text{Current Hazard Score}} = 1.667 - 0.924\ C, \text{ where C is the current hazard score,}$$

yielded an R^2 of .774 with the current hazard score coefficient significant at the .01 level. This result would seem to indicate that inspectors do, indeed, anchor their potential hazard assessments to current hazard conditions, but the level of anchoring changes based upon the present condition of the material. For example, undamaged material with a score of .3, inspectors increase the current score by 40 percent to determine the potential hazard score. For damaged material (say, $C = .5$), the potential score is only increased by 20 percent and for currently significantly damaged material ($C = .7$), the potential hazard score is increased less than 10 percent above the current hazard score.

DISCUSSION

In discussing the results of the analysis, the usual disclaimers must be made whenever a simulation technique is employed to model a subjective judgment. The true feeling of exploring a dusty dark crawlspace to complete an asbestos

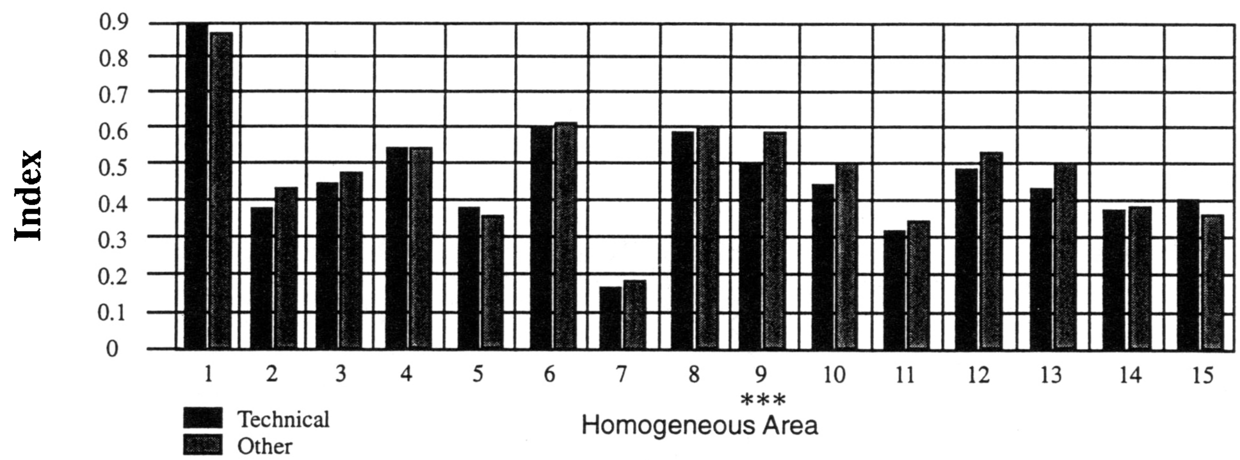

Figure 5. Judgments of inspectors with and without technical backgrounds:
Current conditions.

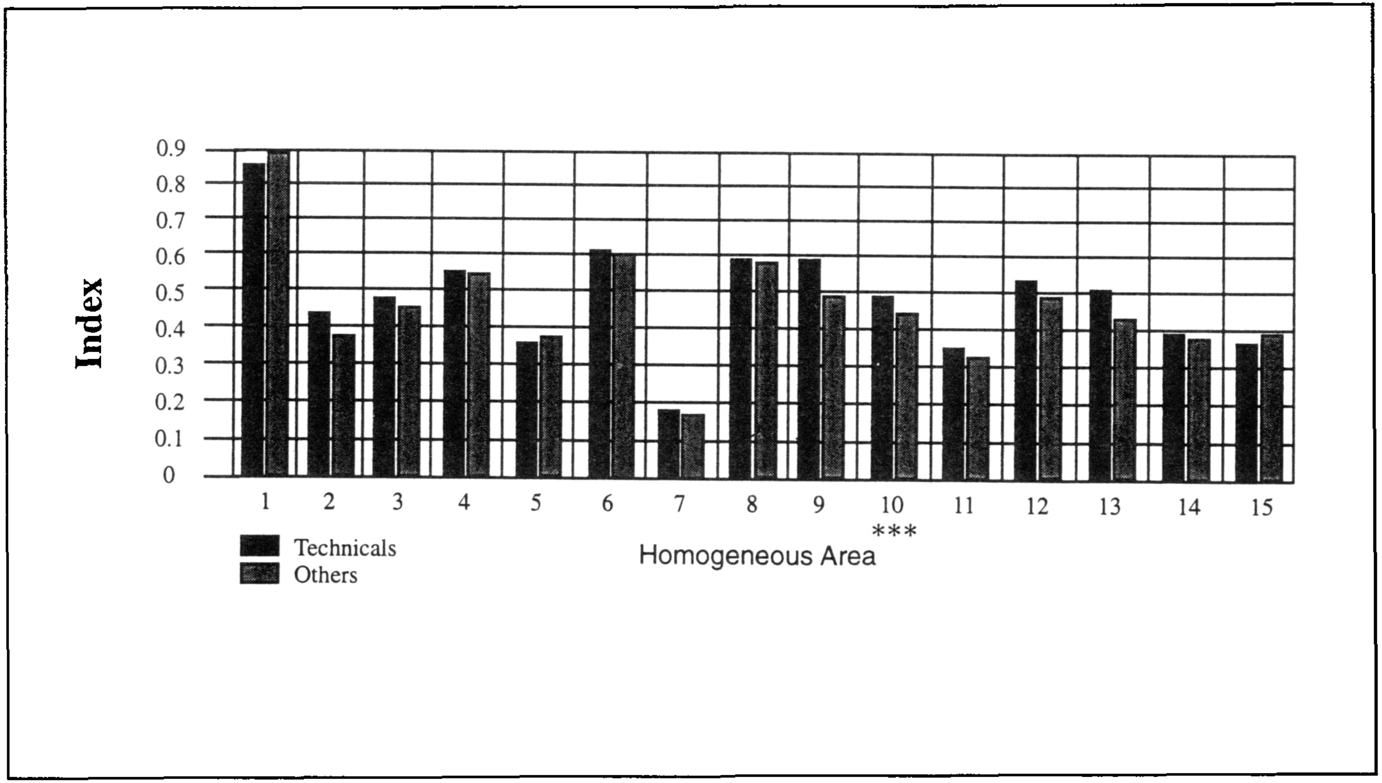

Figure 6. Judgments of inspectors with and without technical backgrounds: Potential hazard conditions.

inspection simply cannot be reproduced by examining a set of photographs and descriptive materials in a classroom. The logistical problems of designing a true field assessment have already been mentioned. In defense of the technique, it should be noted that the authors assumed that judgments made using the workbook would understate the true variance in judgments made under field conditions. Considering the high level of variance evidenced in the simulation, the conclusion that the variability in actual inspector judgments in the field would be high seems warranted.

The study does seem to point to the possible existence of a learning curve effect by inspectors. The learning seems to result in lowering the assessment of the level of damage, not in a significant decrease in the variability of judgments. No compelling evidence was developed by the survey indicating that the inclusion of an apprenticeship period in the certification process would materially improve the consistency of inspector judgments. Likewise survey results gave no indication that technical or occupational prerequisites for certification would reduce the variability of judgments made by inspectors. For judgments concerning potential hazards (in which ventilation and disturbance concepts used are familiar to industrial hygienists, architects, and possibly engineers) no improvements were found in consistency due to occupational background.

The simulation did show a relationship between judgments concerning existing hazard condition and potential hazard condition. The strength of the relationship calls into question the value of attempts to forecast future conditions based upon disturbance factors by inspectors. More frequent spot inspection of current conditions may prove more reliable than attempts to forecast future conditions based upon disturbance factors. The training of on-site custodial and building maintenance personnel in inspection techniques to more frequently assess current hazard conditions may be more effective than the use of certified inspectors to forecast potential future risks.

Perhaps the clearest policy implication from the study relates to the nature of the professional training itself. The existing manuals and training do have some pictorial examples of different conditions but present courses do not use a wide array of visual training techniques to simulate field conditions. The improvement in visual training technology and aids could yield a more consistent, defensible and cost-effective public health program to monitor hazards related to asbestos.

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