Assessing Occupational Safety and Health Training

A Literature Review

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Foreword

Occupational safety and health training remains a fundamental element in workplace hazard control programs. As training objectives, recognition of job hazards, learning safe work practices and appreciating other preventive measures are expected to contribute to the goal of reducing occupational risk of injury and disease. This report reviews data found in the literature reflecting the significance of training in meeting these kinds of objectives and outcomes. As will be seen, there is much positive evidence but the results seem very selective and highly qualified. An analysis to identify factors underlying a successful training experience is also presented and does confirm basic principles of learning. Here too, however, important gaps are noted in the available data. The document proceeds to offer an agenda for addressing outstanding needs and ways for strengthening the role that training can play in improving workplace safety and health. The reader audience concerned with these kinds of issues should find this report to be most informative.

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Abstract

More than 100 Occupational Safety and Health Administration (OSHA) standards for hazard control in the workplace contain requirements for training aimed at reducing risk factors for injury or disease; others limit certain jobs to persons deemed competent by virtue of special training. A literature review was undertaken to assess the merits of such training rules to achieve this objective and to sort out factors of consequence. The review focussed heavily on published reports, primarily drawn from the period 1980 through 1996, wherein training was used as an intervention effort to reduce risk of work-related injury and disease. Eighty (80) such reports were found and gave overwhelming evidence to show the merits of training in increasing worker knowledge of job hazards, and in effecting safer work practices and other positive actions in a wide array of worksites. Reports from select surveys and investigations of worker injuries and workplace fatalities were also accessed with many implicating lack of training as a contributing factor to the mishaps. In still other studies, workplace training devoted to first aid instruction showed linkage to reduced worker injury rates, suggesting that even this kind of training has benefits to job safety overall.

A critical analysis of the above findings found certain qualifications in viewing training impacts and successes with regard to current workplace standards. For example, most of the reported training intervention studies did not address OSHA training rules per se, and knowledge gain and safe behavior measures were used in many evaluations as opposed to actual injury/disease indicators. Also, in some instances, the training was coupled with other forms of intervention to make attribution difficult. Training deficits noted in some surveys of work injury cases lacked for confirmation and no information was available on the quality of the instruction if given at all.

Despite the above reservations and uncertainties, training's role as a necessary element in developing and maintaining effective hazard control activities remained firmly supported by the available literature. What did emerge from this review and analysis was an appreciation of meaningful training procedures and the recognition of factors both within and beyond the training process that could greatly affect its impact. In this regard, the OSHA voluntary training guidelines were described along with illustrations from the reports to show how the various steps contained within them can be met in realistic ways and have merit in framing an effective program. In addition, factors both within and beyond the training process were assessed for their effects on training outcomes based on data found in the reviewed literature. Variables such as size of training group, length/frequency of training, manner of instruction, and trainer credentials were each shown to be significant determinants to the training process. Equally important were extra-training factors such as goal setting, feedback and motivational incentives along with managerial actions to promote the transfer of learning to the jobsite.

Based on the literature review, follow-on efforts to address outstanding issues and needs regarding effective occupational safety and health training were noted.

Executive Summary

This review sought evidence from the literature bearing on two questions: Are occupational safety and health training (OS&H) requirements, as cited in many Federal standards governing workplace conditions and operations, effective in reducing work related injury and illness? Does the available evidence show certain training factors or practices to be more important than others in having positive effects on these outcome measures?

The literature search focussed on reports of training intervention efforts designed in whole or in part to enhance worker knowledge of workplace hazards, effect behavior changes to ensure compliance with safe work practices, or prompt other actions aimed at reducing the risk of occupational injury or disease. Eighty (80) such reports met criteria for inclusion. They were products of two literature searches. The first search covered the period up to 1993; the second extended the first search through 1996. The included work came mainly from the period 1980 through 1996 and, by intent, addressed five types of hazardous agents. These were: traumatic injury forces, toxic chemicals/materials, harmful physical factors, ergonomic stressors, and biologic/infectious agents as encountered in an array of work settings. The search also examined data from select surveys and investigative reports where training factors were either implicated in the etiology of workplace injury or disease incidents or, alternatively, were considered a key element to the success of worksite hazard control programs that showed exemplary safety and health records. Still another source for information was reports of worksite training directed to other needs (e.g., first aid) but that had apparent positive effects on worksite safety and health indicators as well.

With regard to answering the first question, the literature accessed and reviewed in this report offered much direct and indirect evidence to show the benefits of training in establishing safe and healthful working conditions. The intervention studies in particular were especially supportive. Findings here were near unanimous in showing how training can attain objectives such as increased hazard awareness among the workers at risk, knowledge of and adoption of safe work practices, and other actions that improve workplace safety and health protection. Data from other types of studies suggested too that lack of required training may have contributed to events where workers were injured or killed.

Although affirming the effectiveness of training to meet hazard control objectives, this review also drew attention to some shortcomings in the supportive data. For example, the training intervention work that offered the most positive evidence did not address OSHA training requirements per se. Rather, the training interventions targeted site-specific problems, and while showing success in resolving such problems, i.e., improving safety performance, their exact relationship to OSHA mandated training rules was unclear. Moreover, where studies reported lower injury rates, reduced lost time or medical costs after training, analyses were lacking to show how the improvements could be accounted for by the positive results from training when measured in terms of knowledge gain or behavior indicators. One study that attempted such an analysis found that the targeted training could only account for 25% of the observed reduction in injury rate. Also, in some instances, the training was coupled to

other forms of intervention (engineering, ergonomic) so as to make attribution even more difficult. Still another tempering fact was that successful training results appeared greatly influenced by "extra-training" considerations. Management's role/support of safety training and its transfer to the jobsite, setting goals and providing feedback to motivate use of the knowledge gained, and offering incentives or rewards for reinforcing safe performance all seemed crucial to attaining a positive result. These types of factors are not acknowledged in OSHA training requirements. It is noteworthy that a proposed OSHA safety and health program standard does recognize the need for management actions to support OS&H training among other critical components.

Some reports that suggested training deficits as factors contributing to injury/health problems lacked for confirmatory information. In other reports, workers who had received training to protect them against certain job hazards were nevertheless afflicted. Missing in these cases was information about the quality of the training offered; whether it met OSHA requirements, or took note of any of the extra-training factors noted above.

Even with the above reservations and uncertainties, however, the role of training as a necessary element in developing and maintaining effective hazard control activities appeared firm. Indeed, the issue was not so much whether OS&H training could make a difference in reducing risks from workplace hazards. Clearly, it can. But rather ascertaining the conditions for maximizing these training effects. This was the second question posed in this review and two approaches were used to offer a response. One effort focussed on the OSHA voluntary training guidelines wherein examples were extracted from the set of intervention studies to highlight the different steps that had to be taken. Various exhibits in this exercise showed how the steps could be met in realistic ways and could have merit in framing and implementing an effective training program.

A second approach considered factors not covered in the OSHA guidelines but more specific to the training process itself or the attainment of its objectives. Variables included were the size of training group, length and/or frequency of training, manner of instruction, trainer credentials, and training/transfer conditions. Addressed among the latter conditions were extra-training factors such as management/supervisory roles and motivational techniques for reinforcing the learning at the jobsite. The intervention studies were examined for data that could justify statements as to the significance of these factors and/or conditions and where they had the greatest potential for effecting successful training outcomes. A set of statements, tying together evaluative information from the different reports, emerged from this exercise. Some were more supportable than others owing to limitations in the data contained in the reports under review. Most statements about specific factors agreed with concepts in the general learning and motivation literature, i.e., increases in training time per unit group of workers or use of more frequent and shorter sessions suggested more favorable outcomes as did active learning experiences stressing jobsite applications. Some unique extensions or refinements were also noted such as the added benefits of having supervisors or foremen assume a more active trainer role in workplace safety and health training as opposed to others who may have that special responsibility. Particular attention was drawn to the length and frequency of training because of its implications for training schedules, both for initial and for refresher instruction. Needs to develop a decision logic for this purpose were mentioned along with some of the variables to be addressed.

Suggestions for follow-on work were offered to take account of the gaps in the reviewed literature or other shortcomings in responding to the two questions posed. Among those recommended were:

1) Undertaking studies to ascertain how industry is responding to OSHA training rules and the quality of such efforts. The major data set used in this literature review were researcher directed efforts and, for that reason were not the norm. Focussing the efforts on the most prevalent types of injuries and illnesses and selecting industries or work operations where they are most recurrent would be ideal. Differences in how the mandated training rules were met at the various selected sites and links between the training undertaken and specific injury and disease risk factors would be analyzed. The extent to which the operant practices followed OSHA training guidelines, and the resulting experiences could offer an important reference in gauging their utility.

2) Conducting in-depth studies of training practices and their interrelationship with other elements in an establishment's hazard control program. Directing this effort at companies showing exemplary safety and health records could offer program models for effective training that can best complement or enhance other workplace measures aimed at maximizing risk management.

3) Using case-control or cohort studies to compare differences in the level of training of workers injured or afflicted by occupational disease against those not so affected. The intent here would be to get a better assessment of how training deficits can lead to such problems. Such an analysis would require measures to separate out many nontraining factors that could also be responsible for apparent differences in these cases.

4) Convene workshops to discuss issues concerned with the effectiveness of worksite OS&H training both now and in the future. Invitees would include experts and practitioners conversant with OS&H training, job skills training, health education, organizational behavior and evaluation subject areas. The workshops would seek to pool ideas bearing on the questions posed in this report and added concerns such as the adequacy of current regulatory language in OSHA training rules, future training challenges due to changing workplace technologies, worker demographics, measurement outcomes for assessing the effectiveness of training, the merit of merging different workplace training domains (i.e., OS&H training, job skills training, worksite health promotion), and other issues.

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1

Introduction

Hazard control and prevention strategies to assure every working man and woman safe, healthful workplace conditions regard training as an axiomatic part of all such efforts. To reinforce this point, requirements for worker safety and health training are found in more than 100 occupational safety and health standards promulgated by the Occupational Safety and Health Administration (OSHA); others limit certain jobs assignments to persons judged competent by way of special training. Yet, the merits of training provisions in worksite hazard control regulations and for hazard control efforts in general have not been without question. Indeed, instances where training has been shown to be ineffective in reducing work related disabilities have been reported (Tan et al., 1991, Snook, Campanelli & Hart, 1978, Linnemann, et al., 1991), and at least one review has raised concerns about the worth of workplace safety training programs (Hale, 1984). In its defense, training shortcomings could reflect use of inadequate instructional techniques or situational factors that confound the learning process or its objectives. More importantly, however, the notion that training is somehow exempt from the accountability demands of business operations is no longer tenable. Moreover, in appreciating that adherence to training rules imposes added costs on responsible employers and extra burdens on workers too, knowledge of factors that can influence success in training efforts would be especially important. Indeed, one could argue that faulty or bad training may have worse consequences than no training at all.

It was these issues that prompted this literature review. The originally conceived purpose was to address two questions:

Q-1: Can the occupational safety and health (OS&H) training requirements cited in numerous Federal standards governing workplace conditions and operations be shown to be truly effective in reducing work related injuries and illness?

Q-2: Does the evidence single out certain elements or characteristics of training programs as having the most positive effects on worker safety and health?

Approaches to answering these questions would seem straightforward. Among the more obvious:

(1) Search the literature for reports on how employers implemented applicable OSHA training requirements and the associated change in their work injury and disease experience.

(2) Locate data sources comparing the extent and nature of OS&H training given workers who incurred work related injury or disease with those who have not but who are in similar occupations or work situations.

(3) Analyze the safety/health training practices of employers having exemplary injury/disease control programs and contrast them with others having worse performance but comparable job operations, workforce size/makeup, and other workplace factors.

As noted in the course of this review, the existing literature only partially satisfies these approaches. For example, reports of efforts to comply with prescribed OSHA training rules are relatively few; more common in the literature are training studies targeting site-specific problems that may or may not be covered by regulation. Knowledge gain, attitude change, indications of safer work procedures being adopted by the workers are most frequently used to measure the training impact. Fewer studies note reduced injuries or disease outcomes from training, and if they do, there are cautions about drawing cause-effect conclusions. Results of epidemiology studies of occupational injury and disease may suggest training shortcomings as contributing factors but lack for baseline data or other evidence needed to support such claims. Assessments of OS&H training practices or the merits of certain instructional methods as found in the literature may not always be able to separate training-specific effects from other workplace factors. Also, in many instances, data collection for worksite training evaluation purposes may not always follow sound study design principles.

Clearly, then, the current literature cannot supply complete answers to the questions posed. Definitive responses require more research and some suggestions for such work are described at the conclusion of this report. Even with the above reservations, the benefits of a literature review at this time are believed twofold. First, to offer a preliminary appraisal of the merits of training directed to workplace safety and health concerns. Second, to offer a conceptual framework for treating OS&H training so as to clarify the issues that should be addressed in follow-on efforts.

Although the literature has much theory on learning having relevance to training, this review is not theory driven, i.e., intended to serve as a test of specific hypotheses derived from specific theoretical formulations. As will be noted, the treatment in various places does take account of suggested training models or guidelines for purposes of organizing and analyzing the material under review.

It is envisioned that this report can serve different audiences. For one, policy-makers engaged in setting OS&H standards need to be assured that training requirements are essential to achieving improved workplace safety and health. Finding such supportive evidence for training rules would offer this assurance. Also, information on whether certain rule formulations have more merit than others in producing successful training results would be of benefit to policy-makers. A second audience would be researchers.

This review reveals both strengths and weaknesses in the database for effective training procedures and factors affecting OS&H training. Especially challenging and needed are studies to definitively tie immediate training results, e.g., increased knowledge of hazards and safer work behaviors, to outcome indicators such as reduced worker injuries and illness. A third and last audience for this report would be those who conduct OS&H training. Indeed, the wealth of training studies appended to this report is an information resource on instructional methods and evaluation techniques. By addressing different types of hazards in a variety of work settings and offering measures for indicating effects, they offer important lessons for OS&H trainers.

II

Occupational Safety and Health Training in Broad Perspective

A. Basic Program Thrusts

OS&H training embodies instructing workers in recognizing known hazards and using available methods for protection. Worker education, in contrast, prepares one to deal with potential hazards or unforeseen problems; guidance is given in ways to become better informed and to seek actions aimed at eliminating the hazard. As explained in a 1985 Office of Technology Assessment (OTA) report on preventing illness and injury in the workplace, the distinction between worker training and education programs is often blurred and depends on the role that the worker is expected to assume in the process. "The ***narrower*** the role, the more the instruction is ***training***; the ***broader*** the role, the more the instruction is ***education***" (OTA, 1985, Pg.189). Much of the information in this review draws on the narrower training reference, but worker education approaches are also acknowledged.

The OTA report included an analysis of 40 worker training and worker education programs conducted by business firms, trade associations, unions, hospitals and universities, and coalitions of OS&H groups. The analysis of activities and objectives suggested four types of programs: fundamental, recognition, problem-solving, and empowerment programs.

Fundamentals Programs: These programs involve instruction in prevention of work-related injury and illness through proper use and maintenance of tools, equipment, materials; knowledge of emergency procedures; personal hygiene measures; needs for medical monitoring; and use of personal protective equipment for non-routine operations or as an interim safeguard until engineering controls can be implemented.

Training interventions having these objectives permeate the literature and comprise most of the reports in Appendix A, which offers an inventory of studies aimed at evaluating the effectiveness of OS&H training for controlling workplace hazards.

Recognition Programs: These programs include instruction emphasizing awareness of workplace hazards; knowledge of methods of hazard elimination or control; understanding right-to-know laws and ways for collecting information on workplace hazards; recognizing symptoms of toxic exposures; and observing and reporting hazards or potential hazards to appropriate bodies. Training activities of this type were spurred largely by the OSHA Hazard Communication Standard (OSHA, 1983). The

standard required employers to inform workers of chemical hazards found in their work areas and of ways to reduce apparent risk. Use of Material Safety Data Sheets and labels along with training are the three means prescribed for communicating the essential information. Several reports evaluating training efforts of this type are found in Appendix A.

Problem-Solving Programs: Instruction is aimed at giving workers the information and skills enabling them to participate in hazard recognition and control activities; to help identify/solve problems through teamwork, to use union and management means, and to exercise rights to have outside agencies investigate workplace hazards when warranted. Inviting worker input in company planning or in design of new operations or processes is recognized as a viable means for improving productivity, quality of products, and worker motivation. Extending this approach to hazard control seems reasonable especially since workers, owing to their everyday job work experience, possess an intimate knowledge of the hazards connected with their jobs and could be a rich source for corrective ideas. One report in assessing a worker participation approach to hazard control at a worksite (Lin & Cohen, 1983) found the overall effort to be successful but at the same time took note of some gaps of worker knowledge for which added worker instruction would have been of benefit. This report is listed in Appendix A along with other reports of union-sponsored efforts to sharpen worker skills in addressing the requirements of specific OS&H standards so that they could play a more effective role in responding to their workplace needs.

Empowerment Programs: These programs provide instruction to build and broaden worker skills in hazard recognition and problem-solving skills much like that noted above. Emphasis, however, is on worker activism with the goal of ensuring their rights to an illness-and injury-free workplace (Wallerstein & Baker, 1994). Hence, the program aims at enabling workers to effect necessary control measures through educating co-workers and supervisors, and through use of committee processes or in health/safety contract negotiations. This approach is in accord with the current "Total Quality Management" philosophy — having rank-and-file workers along with their supervisors share greater roles in and be more accountable for addressing workplace hazard control needs. Several reports of union and university coalitions engaged in furnishing such training and some first attempts to provide outcome measures are noted in Appendix A.

The above types of training suggest a progression from a workforce learning basic forms of protection to known hazards, through instruction aimed at enhancing their awareness of potential problems and problem-solving skills, and then learning how to make it all happen in their workplaces. Although treated separately, any given training program may contain elements of these approaches in varying degrees.

B. Worksite Training on Health Protection/Health Promotion

The aforementioned training and education activities are all directed to worksite health protection, that is, to controlling occupational/environmental risk factors for disease or injury. They should not be confused with worksite health promotion programs that also involve training/education activities but whose objectives are to alter personal lifestyle factors that may pose risks to one's health and well-being. Instruction here targets smoking, substance abuse, inadequate diet, poor physical fitness among other problems and the intent is to effect behavior change for risk reduction.

Personal lifestyle and occupational risk factors may interact in ways that can heighten the potential for adverse outcomes. For example, asbestos workers who smoke may have a 10-fold greater risk for lung cancer (Hammond, et al., 1979); alcohol or illicit drug use has been implicated in work accidents in high risk jobs (Holcomb, Lehman & Simpson, 1993). Alternatively, exercise training for enhancing physical fitness has been suggested as an added means to limit strains from jobs imposing undue stress on the musculoskeletal system (Genaidy, Gupta, & Alshedi, 1990; Hilyer et al., 1990; Shi, 1993). For these reasons, training and education activities addressing worksite health protection and health protection goals in combination may have mutually reinforcing effects. While health promotion studies are outside the scope of this literature review, some reports of these worksite activities have been evaluated from the standpoint of reducing occupational risks and will be so noted.

III

Occupational Safety and Health Training in Relation to Other Worksite Activities

OS&H training as implemented at the workplace rarely has a stand-alone status. For example, OS&H training may be a natural part of job skills training or a simple add-on. On-the-job type of training, of necessity, would have to cover both objectives. In some cases, work methods to be learned and safe work practices prescribed by OSHA standards are much the same. In occupations such as logging, "poor technique" is widely reported as a cause of injury with inadequate training cited as the underlying problem. This shortcoming refers to a failure to develop (learn) proper work methods and the safety precautions that derive from them (Slappendel et al., 1993).

OS&H training is also an element of hazard control programming. Instruction in hazard recognition and control methods, knowledge of emergency procedures, and use of personal protective equipment may or may not be distinctive—the degree depends on what OSHA requirements may dictate. The Hazard Communication Standard (OSHA, 1983) for example, requires a written training plan describing the nature of instruction to ensure workers understand the chemical hazards to which they might be exposed, recognition of symptoms of overexposure, safeguards to be taken, etc. Other standards merely acknowledge the need for training but are less explicit as to requiring evidence of a plan for its implementation. Although not always recognized, OS&H training may also be needed to cover operational aspects of engineering or physical hazard control systems so that their benefits are realized to the fullest extent.

OS&H instruction as a component of both regular job training and worksite hazard control program practices is depicted in Figure 1 as nested in and representing the overlapping parts of these two types of activities. Encircling the job training and occupational safety and health program efforts are factors which can shape the success of these activities and their respective impacts on productivity and safety/health experience. Indeed, the transferability of training to actual jobsite demands, use of promotional or motivational efforts to drive the training exercise as well as boost post-training performance in both productivity and hazard control terms, and management's commitment to these activities as communicated to the workers can do much to affect these kinds of outcomes. Encompassing all of the above and shaping the ultimate results are an employer's goals and objectives. Presumably, management policies and actions that do not put company productivity and worker safety and health in conflict but rather stress their positive interrelationships would be ideal.

Viewing OS&H training in this context underscores the difficulty in attempts to treat or evaluate its effects separate from other workplace considerations. This is especially

true if "bottom line" outcomes such as work related injuries and illness are used in the assessment. As will be noted, many evaluations of OS&H training use measures more immediate to the learning process itself (e.g., knowledge gained); others may take account of the instruction plus certain extra- or post-training factors in assessing on-the-job safety performance. In these instances, surrogate indicators for injury or disease reduction may be used (e.g., increased compliance with safe work practices and/or associated changes in exposure levels); these indicators can offer more opportunity for discerning effects than injury or illness measures. It must be remembered that work related injury or disease cases at least at the individual employer level are rare events which can complicate efforts at evaluating change.

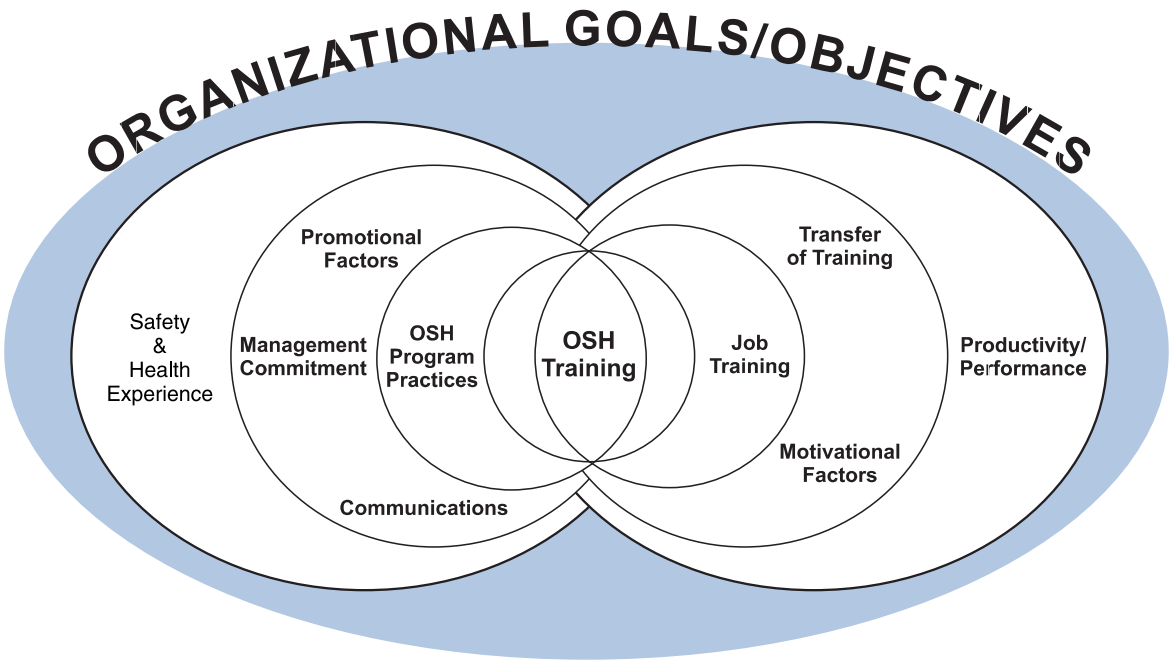

Figure 1. Depiction of occupational safety/health (OSH) training as nested in other employer programs which are affected by numerous extra- or post-training factors. Interactions here complicate efforts to assess training-specific impacts on safety/health experience or productivity/performance measures. Employer goals and objectives and related policies ultimately determine the priorities or trade-offs between the two outcomes.

IV

General Training Considerations

A. Some Definitions

In general, ***training*** refers to instruction and practice for acquiring skills and knowledge of rules, concepts, or attitudes necessary to function effectively in specified task situations. With regard to OS&H, training can consist of instruction in hazard recognition and control measures, learning safe work practices and proper use of personal protective equipment, and acquiring knowledge of emergency procedures and preventive actions. As noted in the OTA report (1985), training could also provide workers with ways to obtain added information about potential hazards and their control; they could gain skills to assume a more active role in implementing hazard control programs or to effect organizational changes that would enhance worksite protection.

Performance represents observable actions or behaviors reflecting the knowledge or skill acquired from training to meet a task demand. With regard to OS&H, performance can mean signs of complying with safe work practices, using protective equipment as prescribed, demonstrating increased awareness of hazards by reporting unsafe conditions to prompt corrective efforts, and executing emergency procedures should such events occur.

Motivation refers to processes or conditions that can energize and direct a person's behaviors in ways intended to gain rewards or satisfy needs. Setting goals for performance coincident with learning objectives and use of feed-back to note progress have motivational value. With regard to OS&H, motivation can mean one's readiness to adopt or exhibit safe behaviors, take precautions, or carry out self-protective actions as instructed. Bonuses, prizes, or special recognition can act as motivational ***incentives*** or rewards in eliciting as well as reinforcing these behaviors when they are displayed.

Knowledge or skills acquired in training may not always result in improved performance in actual work situations. This may indicate 1) lack of suitable motivation, 2) training content does not fit job demands (i.e., a problem in defining suitable training objectives, or 3) dissimilarity or conflicts between the instruction/practice in training conditions when compared to actual job conditions (i.e., a problem in transfer of training). More is said about this in the sections to follow.

B. Critical Training Elements

Different authoritative reviews of the general training literature (Goldstein & Buxton (1982), Campbell (1988), Tannenbaum & Yukl (1992)), and job training in particular, emphasize the importance of certain elements as critical to an effective program. They are noted below. The OSHA set of voluntary training guidelines to assist employers in furnishing safety and health information and instruction to workers (OSHA, 1988) mimics most of the same elements within an OS&H context. They are treated in a later section.

1. Needs Assessment

   According to the general literature, training goals presuppose: 1) consistency with organizational goals, 2) the presence of jobs designed to yield performance outputs that meet the organization's goals, and 3) performance levels dependent on knowledge of the job tasks, skill, attentiveness to the work or factors where training can make a difference. On the last point, expecting training to solve problems related to internal organizational conflicts or to overcome deficiencies in equipment or work methods is unrealistic. Job analyses determine which of the relevant performance factors comprise the highest priority training needs either now or in the future. The process includes defining the tasks involved, their order of importance (in terms of frequency, criticality, complexity), and details of the steps necessary to accomplish them.

2. Establishing Training Objectives

   According to the general training literature, the needs assessment provides the information to establish the objectives of the training program. These are stated as observable behaviors expected of the trainee after the instruction, and they may acknowledge the conditions under which they should be performed and the required level of proficiency.

3. Specifying Training Content and Media

   According to the general training literature, content represents the knowledge or skill that the trainee must master to be able to meet the behavioral objectives. The judgement of those who know the job demands is the most common approach to specifying training contents. Other approaches may be the products of problem-solving exercises, or be based on mistakes people make in using a skill such as to design corrective learning measures. Evidence that one teaching method such as lectures, televised instruction, computer-aided instruction, or interactive video methods is superior to another is not that clear (Kearsley, 1991). Much depends on the specific training needs, makeup of trainee group and other factors. Why or how a particular method facilitates learning and how it can be made more effective are issues requiring further study.

4. Accounting for Individual Differences

   According to the general literature, effective training should take account of the characteristics or attributes of the trainees. Aside from differences in aptitude, literacy, or pretraining skill levels, how trainees view the training program in terms of improving their job performance or self-efficacy may dictate variable approaches. The kind and level of training for new job applicants versus long-term or older workers reassigned to the same tasks also has to be addressed.

5. Specifying Learning Conditions

   In general, instructional events comprising the training method should not inhibit, conflict with, or be unrelated to the processes that lead to mastery. If the learning is to develop capabilities in problem-solving techniques, the instructional approach should stress thinking/reasoning approaches not rote memorization. Training methods should require the trainee to use the training content in active or productive ways, e.g., restating or applying principles rather than just recalling them, or adapting the information to new situations rather than mere repetition in the same one. The current literature suggests that using learning events that require productive behavior or that provide appropriate feedback (positive/accurate/credible) and opportunities for practice under conditions that promote transfer to the actual job are ideal.

6. Evaluating Training

   According to Kirkpatrick (1967), training evaluations in the general literature can take four forms which are viewed as a series of steps or levels. They are:

   Step #1: Reaction—How did the trainees like the program? Typically this is done through evaluation sheets completed at the end of the training. Typical items inquire as to whether the material was well organized, relevant to the trainees needs, made interesting through the instructor's manner of presentation or use of visual aids, demonstrations, etc.

   Step #2: Knowledge Gain (or Skills Acquired)—What principles, facts and techniques were learned? Knowledge of facts and principles is usually evaluated via pre/post paper-and-pencil tests or quizzes. Assessment of skills may be done through performance tests before and after training. An untrained or control group can be similarly tested to indicate any differences resulting from just the test-retest experience

Step #3: Behavior Change—What changes in behavior occurred as a result of the program? For this purpose, reports by the trainees themselves (self-appraisals) of their on-the-job performance, or observations by their peers, supervisors, instructors can be used. A time interval between the end of training and the observations may be necessary to allow for the training to be put into practice. Post-training measures taken at different time points are also suggested to determine if the training effect is sustained or needs refreshment. Again similar observations for a control group are recommended to acknowledge any effects from repeated testing. These control data also provide an added reference for gauging the significance of the apparent behavior changes in the training group.

Step #4: Results—What were the tangible results of the program in terms of its objectives or goals for the organization? Did it result in reduced injuries or illness, lower medical costs, improved productivity? As noted in Figure 1, extra- or post-training factors can affect these types of outcomes, and it is not always possible to design evaluations that can isolate the specific training contribution. Undertaking evaluations where these "extra-training factors" are held constant during the pre-and post stages of the training assessment or can be segregated as to their influence through use of suitable control groups are ideal. Needless to say, training impacts at the organization level can require an extended time line especially in using injury/illness outcomes owing to their infrequency.

Criteria for rating training effects are the focus of much discussion in the literature. Several points that deserve mention or added emphasis in light of the subject of this report are:

(1) Past surveys have shown that most in-house assessments of training programs measure only trainee reactions of how well they liked the instruction (Smeltzer, 1979; Smith, 1980; Parker, 1984, Alliger & Janak, 1989). Efforts to determine the extent to which the training content was absorbed or resulted in changes in actual on-the-job behaviors, or had impacts on organizational measures (e.g., quantity/quality of production, sales, absences/turnover, injury/illness rates) were rarer. Among reasons offered for the lack of more intensive efforts at evaluating training were the unquestioned beliefs that training works, that workplace conditions do not readily lend themselves to systematic assessments of training, and that more rigorous attempts will entail high costs. Increasingly, however, there is the call for more extensive training evaluations to verify the benefits as witness this exercise (Blomberg, et al., 1988).

(2) Reinforcing the above statement, trainee reactions to instruction may bear little relationship to the extent of actual learning. (Liking the instruction does not imply learning). Hence, it should not be used as the sole criterion to gauge effectiveness. Similarly, pre- and post-training quizzes or tests of skill showing the gains from instruction may or may not be related to improved on-the-job performance. Needs for multiple measures of effectiveness are apparent.

(3) As already noted in Figure 1, the effect of training is greatly affected by other workplace factors both in the training and post-training environment. Evaluations will need to account for these factors in terms of their influence on the training outcome.

(4) Simple performance outcome measures representing various levels of achievement may be critical to determining the validity of the instruction but may not indicate the factors that influenced these results. Provision of "process" measures, reflecting various amounts of training time, modes of training, trainer attitude/competency, can indicate why the overall results were or were not achieved. This can be important in efforts to revise the training to improve its efficacy.

7. Revising the Training

The evaluation of training as noted by Goldstein and Buxton (1982) offers information as to whether the instruction has had its intended effect on the measures set out for that purpose. Seldom do the data indicate a program was a complete success or a failure, given multiple criteria for gauging the results. Rather, the data may indicate better understanding, retention or application of some course material as compared with others. Gaps or variations in knowledge or competencies resulting from the training may reflect needs to consider more training time, alternative instructional techniques, or more capable instructors.

V

Occupational Safety and Health Training Rules as Found in Current Workplace Standards

A. Nature of Existing OSHA Training Rules

Because of the agency's hazard-by-hazard approach to rule-making, OSHA training requirements in current safety and health standards number in the hundreds and vary greatly in nature. In 1992, OSHA excerpted and collected the various training provisions into a single report to ease the difficulty in locating them in the different standards. OSHA also contracted for a second report to identify and classify their common elements (Meridian Research, 1993). Underlying the latter effort is the thought of developing a stand-alone generic training standard offering possibilities for portraying the existing rules in a more integrated and easier-to-follow format. But this categorization aside, excerpts of the training requirements listed in the OSHA 1992 report show the wide variation in the manner and detail of the applicable training requirements — requirements befitting differences in the scope and complexity of the conditions addressed by the standards. The discussion below elaborates on the variable nature of the training rules with regard to factors such as content, frequency/duration, documentation/assurance, trainer qualifications, and methods used.

1. Content

   A number of standards are quite explicit about what safe practices should be taught. Training rules for pulpwood logging and materials handling operations are of this nature. For example, the pulpwood logging standard lists the details of chainsaw instruction. A sample item: "Chainsaw operators shall be instructed to start the saw at least 10 feet away from the fueling area" (29 CFR 1910.266(c)(5)(v)).[1] Similar exposition occurs in a materials handling standard dealing with the servicing of single rim wheels. In this case the instruction must cover safe work practices so as to ensure ". . . that tires shall be completely deflated by removal of the valve core before demounting; mounting and demounting of the tire shall only be done from the narrow ledge side of the wheel; tires shall not be inflated when any flat solid surface is in the trajectory and within one foot of the sidewall" (29 CFR 1910.177(g)(1)(2)(7). In contrast, other standards are more general as to the content of the training. For example,

[1] Excerpts of the training standards cited in Chapter V are taken from the OSHA (1992) report. More complete statements are found in Collert (1996).

the powered industrial truck standard states: “Only trained and authorized operators shall be permitted to operate a powered industrial truck. Methods shall be devised to train operators in the safe operation of powered industrial trucks” (29 CFR 1910.178). Nothing more is specified. Still other standards acknowledge topics to be covered (e.g., recognition of hazardous conditions, risk factors and potential outcomes, needs for and means for hazard control) but do not go further, thus leaving the specific content up to the employer.

2. Frequency/Duration

   Standards covering exposures to toxic agents dictate that employees receive training before an initial job placement and repeat training on some periodic basis. Reflecting more explicit requirements, the Hazardous Waste Operations and Emergency Standard (29 CFR 1910.120(e)) indicates minimum durations for initial training offsite and supervised onsite instruction plus yearly refresher training. At the other extreme, a number of standards make no reference either to the duration of required training or to the need for repeat or follow-up instruction.

3. Documentation/Assurance

   Certain standards require evidence of a formal training plan or training materials, or both as well as written documents certifying successful completion of the necessary training. The standards covering powered platform operations (29 CFR 1910.66) and hazardous waste operations and emergency response (29 CFR 1910.120) contain such provisions. So too do various standards governing exposures to toxic chemicals and harmful dusts. The regulation on asbestos abatement work first drafted by the Environmental Protection Agency and adopted by OSHA (29 CFR 1915 1001(k)(9)) even requires written examinations of the trainees and attainment of a minimum score to assure competency. The language in most other standards is less specific about either the needs for a formalized program, records of employee participation or achievement. A number of standards indicate that employees shall demonstrate proficiency following instruction but do not actually require certification.

4. Trainer Qualifications and Specialty Training

   Some standards indicate teaching requirements for those slated to instruct employees or stipulate tasks to be undertaken by competent persons. Competent persons are defined as those having acquired necessary skills by virtue of attending training schools, holding academic degrees, or possessing specialty experience. Related to this point, the hazardous waste operations and emergency response standard acknowledges separate training requirements for waste site workers versus those having management or supervisor roles. The revised OSHA asbestos standard mentioned above (29 CFR 1915.1001(k)(9)) dictates different training for asbestos abatement workers, supervisors, inspectors, management planners, and project designers.

5. Methods

With few exceptions, current standards do not dictate methods to be used in meeting the required training objectives. One standard on powered platform operations (29 CFR 1910.66)) mentions that pictorial methods can be used instead of written work procedures in the training activity. Several others stipulate a portion of the training time to be a "hands-on" learning experience. More generally, however, the "how to" of training is left to the discretion of the employer.

Foreign Occupational Safety and Health Training Rules

Heath in a series of four papers (1982(a), 1982(b), 1982(c), 1982(d) summarized OS&H training as practiced in six industrialized western nations which included Canada, Great Britain, Federal Republic of Germany, Sweden, France and the U.S.. Like the U.S., legislation requiring employers to provide information and instruction on workplace risks were also found in the other five countries. There was much similarity too in how rules on training content and informational materials pertaining to use of equipment, exposures to agents were developed by governmental agencies with inputs from health and safety professionals, trade associations, union and insurance groups. Heath noted two major differences between the U.S. and the other countries in the rule-making area. One was that foreign country legislation was far more precise than that in the U.S. in designating who was responsible for carrying out the training requirements in a work establishment. An excerpt from one country reads: "Every employer shall ensure the adequate direction and instruction of workers in the safe performance of their duties. Every supervisor shall be responsible for the proper instruction of workers under his direction or control and for ensuring that the work is performed without undue risk." (cited in Heath 1982(a), pg. 8). Second, the U.S. was the lone country providing central government funding to support job safety and health training programs. In the foreign countries, this burden was assumed by employers, insurance companies, private safety and health organizations. But more pertinent to the subject of this literature review, Heath found that the evidence in these countries to show that training was an effective countermeasure to reducing worksite injury and illness ranged from poor to nonexistent (Heath, 1982(b)).

B. OSHA Voluntary Training Guidelines

In the matter of how best to implement required training, OSHA has training guidelines to assist employers in furnishing safety and health information and instruction to workers (OSHA, 1988a). The guidelines are voluntary and are meant to enhance or supplement other employer training activities. Tailoring their application to meet individual worksite needs or local working conditions is encouraged.

The OSHA voluntary training guidelines follow a model whose elements reiterate most of those in the general job training literature reviewed earlier. The seven guidelines below makes this readily apparent.

1. Determining If Training Is Needed

   Are the needs for hazard control more readily solvable by training, i.e., increased knowledge of a work process or adoption of safe work practices as opposed to engineering or physical control alternatives?

2. Identifying Training Needs

   Job hazard analyses plus examinations of company health/safety records and worker perceptions of job risks are suggested as means for identifying what training is needed and where improvements can be made in hazard control. Obviously, reference to applicable federal/state standards will also shape the training content.

3. Identifying Goals and Objectives

   The OSHA guidelines call for identifying what the instruction is intended to achieve and defining evidence for it being met in explicit, observable terms. OSHA indicates that a specific objective (e.g., "An employee will be able to describe how a respirator works, how to ensure an effective fitting, and when it should be used") is preferable to a vague goal (e.g., "The employee will understand the use of a respirator")(Pg. 5, OSHA, 1992).

4. Developing Learning Activities

   The OSHA guidelines suggest learning activities be aimed at well-defined objectives and in substance take account of mental and/or physical skill factors as may be required to meet specified needs. The actual content or coverage of topics may be dictated by OSHA regulations. Instruction that employs task sequences and situations to simulate the actual job conditions are suggested to ensure the transfer of this training to the work situation. Like the general training literature, the OSHA guidelines acknowledge that training materials and techniques can vary; the important point is that the activities allow the employees to demonstrate that they have acquired the desired knowledge.

5. Conducting the Training

   This OSHA guideline, like the one in the general training literature, stresses the need for an instructional format that invites worker inputs into the training process, and provides for hands-on experiences and exercises promoting active learning. It also makes reference to other means of motivating and maintaining worker interest. Relating the training to their current skill levels and experiences and emphasizing the benefits (increased worker knowledge and skills, more marketable attrib-

utes as an employee who is informed and safety conscious) are among the ideas offered.

6. Evaluating Program Effectiveness

   Each program should determine whether the training has accomplished its goal. Trainee opinions, supervisor observations and workplace improvements resulting in reduced injury or illness are among the means recognized for this purpose. As already mentioned, incidents of illness/injuries for rating the impact of OS&H training programs or other intervention activities are such rare events that surrogate measures may be needed. Frequencies of "near miss" incidents, evidence of reduced exposure levels to a hazard, measures of compliance with safe work practices offer possibilities. Also, reduced injury and disease as outcomes of training would have to account for other factors as well. (See Figure 1).

7. Improving the Program

   If the evaluation proved that the training was deficient, efforts to revise aspects of the training or to offer periodic retraining may be in order. Repeating the steps in the training model may help determine where course revision is needed.

   The OSHA voluntary training guidelines also contain suggestions for identifying those workers who may be at higher levels of risk and thus have the greatest need for training. Occupations posing known exposure hazards or otherwise shown to be associated with excess injury/illness are one determinant. The age and job service of the worker group in question can be another. (Young, new workers show a disproportionate number of injuries and illnesses.) Still another may be the size of the establishment. (Though the pattern may vary with industry, medium size companies (50 to 249 workers) tend to have higher incident rates than the rates for smaller or larger firms (Bureau of Labor Statistics, 1997).

C. Summary

Upon reflection, the following points summarize the current state of affairs regarding the regulatory language covering training in most OSHA standards.

(1) Requirements appear fragmented without a sense of a whole plan. Steps to realize training objectives are rarely given. (As the OSHA voluntary training guidelines are a recent development, older standards lacked for an adequate frame of reference). The most detailed requirements for training are found in the Hazardous Waste Operations and Emergency Response standard (1910.120) and the OSHA adoption of the EPA asbestos abatement work rule (40 CFR 763(e)Appendix (C). These provisions may be a prototype for addressing training needs in future rule formulations.

(2) Without explicit requirements for a plan embodying more of the elements to meet the training objectives cited in the standards, employers may opt for minimal efforts whose results are marginal at best.

(3) Perhaps most critical is the need to ascertain whether the OSHA voluntary plan has merit. Reports of field efforts to implement various aspects of the guidelines and the resultant indications of success or failure in terms of impacting workplace safety/health problems can offer evidence. Further, a review and analyses of this work could define factors that would realize the training objectives and improve safety/health outcomes. The balance of this review is devoted to this task.

VI

Data on Effectiveness of Occupational Safety/Health Training

A. Nature of the Literature Review

This review sought empirical information relevant to assessing whether OS&H training as dictated by OSHA standards had any beneficial effects in reducing the risk of work related injury and illness, and factors that were especially critical to successful training efforts. Specifically, the following types of documentation were sought:

(1) Reports of studies where training interventions were used for purposes of reducing apparent worker risks of workplace injury or disease and evaluative data obtained to indicate their significance. References took account of training programs undertaken at specific jobsites, laboratory studies with training simulators, and efforts to implement OSHA training rules by user/affected groups (i.e., unions/trades organizations) and indications of results.

(2) Surveys or investigative reports offering data on training (or the lack thereof), as well as other factors contributing to work related injuries, fatalities, and health problems.

(3) Reports on occupational safety and health program practices for employers having exemplary safety/health performance to isolate training factors that may have contributed to their success.

(4) Other studies in the education/learning field or ancillary areas that deal with issues especially pertinent to effective OS&H training.

Regarding items (1) and (4) above, the literature review was confined to those reports that described training plans and objectives, manner of implementation, methods for evaluation, and data/results reflecting effectiveness. Articles offering testimonials to various training approaches, or anecdotal references were not considered. Item (2) dealt with results from questionnaire surveys of persons having certain types of work injuries and investigative reports of workplace incidents where workers were injured, killed or found to exhibit health problems. The intent in both cases was to examine any references to training in appreciating why and how the injury producing event or health problems occurred. Item (3) sought analytical information on company program practices, especially aspects of worker training that were relatable to their success in hazard control.

B. Data Sources Tapped

The search strategy made use of NIOSHTIC, the National Institute for Occupational Safety and Health database which covers a broad range of OS&H literature, plus other on-line computerized reference systems and abstract listings for specialty areas available through DIALOGUE Information Services and the National Institute of Medicine MEDLARS system. Searches for relevant citations in specialty areas tapped databases in applied psychology (e.g., PsychScan, PsychINFO), education (e.g., ERIC), social science (e.g., Social Scisearch), health planning and administration (e.g., HEALTH/MEDLARS), trade/industry/occupation issues (e.g., AGRICOLA, Trade & Industry ASAP), specific occupational health topics/problems (e.g., CANCERLIT, TOXLINE, TOXLIT), among others.

A total of 25 different reference systems were scanned in the course of searching for documentation. The uniqueness of the indexing systems used with the various information sources coupled with the multidisciplinary nature and use of training concepts made a single list of keywords for searching impractical. In many instances, a customized list of database specific terms made up of a root or common word in combination with free-text search terms having proximal connection to the keyword had to be devised for the search. Some sample terms for one database (MEDLARS) included program-evaluation, risk-management, attitude-to-health, evaluation-studies, dangerous-behavior, inservice-training, patient compliance. Searches for titles through the various databases were conducted while constantly varying the mix of keywords and free-text in essentially a round-robin fashion. This yielded a listing of over 2000 citations which after deleting duplicates, eliminating false hits, was reduced to approximately 700 titles. Abstracts and references to these reports in other reviews found less than 150 to meet one of the four selection requirements noted earlier. The literature base for this review was the product of two searches. The one just described was concluded in 1993 and included reports published no later than that year. A second, subsequent search extended coverage through 1996 and yielded 188 additional titles. Screening abstracts of these reports found no more than 15 to be worthy of further consideration with regard to the purposes of this review.

The references drawn from the two search efforts were mostly from the period 1980 to 1996, though supplemented in some cases by earlier studies believed cogent to training evaluation issues. Final selection ensured representation in five different hazard agent categories which were:

- Injury-producing forces,
- Toxic chemicals or materials,
- Harmful physical agents,
- Ergonomic stressors,
- Biologic/infectious agents.

The 5 agent conditions were chosen to reflect work related exposure risks recognized in various ways by current OSHA standards or those under development. (NOTE: Ergonomic agents were included in the data set in light of OSHA plans to develop a standard for controlling work related risks of musculoskeletal disorders (OSHA, 1992).

C. Training Intervention Studies

1. Data Set and General Observations

APPENDIX A to this report summarizes 80 studies in which training, in whole or part, constituted an intervention effort aimed at hazard control. For this reason, these reports are viewed as offering the pivotal data to this assessment exercise. The studies are classified by five different agent/hazard conditions, namely, injury-producing hazards, chemical agent hazards, physical agent hazards, ergonomic agent hazards, and biologic agent hazards.

To varying degrees, the listed reports met the requirements stated above in describing training objectives, some form of training, efforts at implementation, and data collection on certain measures to evaluate the results of the instruction. Where noted extra-training factors of consequence to the evaluation are also entered in the listing. Although the 80 reports do not exhaust the available literature, they represent a large and diverse sample of empirical work which offers the reader a sense of the types of training efforts that have been conducted in addressing workplace hazards, the approaches used in their evaluation, and the results obtained.

Some overall impressions can be gained from viewing Tables 1 and 2 whose entries are culled from the studies listed in APPENDIX A.[2]

Table 1 tallies the evaluative measures found in the various training intervention studies using a modified version of Kirkpatrick's (1967) classification and the results reported on the measures. Specifically, under the heading of "Subjective/Self-Reports" are columns for "Reaction" (measures of whether the trainee thought the training interesting, worthwhile or relevant); "Knowledge Test" (scores on a quiz or other inquiry to determine their knowledge gain); and "Application" (reports from the trainees that they have changed their work practices as a result of the training or applied the learning in some other way). The

[2] Where the text cites a study summarized in APPENDIX A, the notation (A-I, A-II, A-III, A-IV, or A-V) in bold will appear with the author(s) name(s), year citation to aid the reader in locating the material by section. Specifically, Roman numerals indicate the reference by hazard section: A-I=Injury; A-II= Chemical; A-III= Physical; A-IV= Ergonomic; and A-V= Biologic, and the entries found therein are listed alphabetically by senior author. Example: The work cited as Komaki, Heinzman & Lawson, 1980 **[A-I]** is listed in APPENDIX A in the Injury section under Komaki.

heading “Objective/Surrogates” refers to more independent indicators, listing direct observations of “behavior change” or “other markers” (biological, environmental) that can be a product of the behavior changes. Positive changes from training on either of these measures can serve as surrogates for improved health/safety outcomes. The last columns of the table refer to actual measures of safety/health experience reflecting the organizational impact of the training. Note that some studies used more than one evaluative measure so the total number of entries in Table 1 exceeds the 80 reports.

Table 2 collates the studies in terms of key elements of the methodology employed and related factors in the interventions. The headings and descriptor terms found therein require some explanation. Under “Basic Design” are entries defining whether the data collection for assessment involved only post-training measures on trainees (Post Test), or comparisons between pre- and post-training measures on a trainee group (Pre/Post), or repeated measures on a trainee group before, during and after training referred to as a time series design (TimeSer). In none of these instances was an untrained or control group compared with those receiving the training. The remaining designs did so: One form comparing post-test measures on a trained group versus a non-trained control group (Post/Ctr); another before and after training measures for a trained group compared with similar measures for a non-trained group (Pre/Post/Ctr); and last, a multiple baseline method (MultBsl)

Table 1: Nature of Evaluative Measure Used in Training Interventions and Effects Reported

Hazard or Agent (No. of Reports)	Subjective / Self-Reports			Objective / Surrogates		Organizational Results		
	Reaction Survey	Knowledge Test	Applications	Behavior Change	Other Markers	Reduced Injury	Reduced Illness	Less Cost Days Lost
INJURY++++ (21 Repts)	+	+++	+++++	++ +++++ +/o	+++++++++	 +++ o	+++	
CHEMICAL (22 Repts)	+++++++	+++++++++ +/o	+++++++ ++++++	+++ +/o	++++++	o	o	
PHYSICAL (10 Repts)	+	+++	++	+++++ +/o,+/o		+	+	
ERGONOMIC (19 Repts)	++ o,o,o	+,+/o	+/o	+++++++/o, +/o o	o+	++++	+	+++++
BIOLOGIC (8 Repts)	+	+++++ +/o	++++	+	+	o	+	
TOTALS (80 Repts)	15(+) 3(o)	19(+) 3(+/o)	22(+) 1(+/o)	25(+) 6(+/o) 1(o)	10(+) 1(o)	17(+) 3(o)	3(+) 1(o)	8(+)

KEY:
(+)= Positive effect on measure; (+/o)= Mixed effect; (o)= No effect

where repeated measures were taken on different groups before, during and after training and upon the introduction of other factors which may influence the training outcome. Through staggering the schedule of treatments, the latter method enabled the measures on one group to serve as an added control for measuring training plus other factors affecting other groups.

The training target column in Table 2 uses the OTA categorization (1985) for defining the objectives of the study. As noted earlier, these were defined as learning fundamental work practices (FndtWkPract), training in hazard recognition-awareness (HazRecog), worker directed or participative efforts in hazard recognition and control (WkrPartic), and worker empowerment training for the same purpose (WkrEmpwr). The variables column describes the nature of the training conditions and/or other factors manipulated during training or in the follow-on evaluation. Those noted refer to training only (TrngOnly); feedback (FdBk) with and without goal setting (GlSet); use of incentives (Trng&Incentives); and where the training plan called for specific manipulations of training content/delivery variables (TrngMode).

The post-training measures column takes note of the frequency and time span of the data collected on the evaluative measures. The basic categories were short- versus long-term (ShTm, LgTm), and whether the data were collected one or more times (One, Rep). Long-term (LgTm) refers to a post-training period exceeding 3 months,

The last column, headed “Other Considerations”, identifies other conditions described in the studies that deserved special mention in light of their likely effect on the results. Nature of management support, workplace constraints or aids to facilitating the training or its application in the post-training environment were among the factors noted.

The following observations elaborate upon the summary data contained in Tables 1 and 2:

(1) First and foremost, the number of entries indicating a positive effect attributed to the training or training plus other factors in the intervention is near overwhelming. In Table 1, 119 of 138 entries show a positive change from the training or instructional effort on the measures indicated and 10 others show partial success. In only nine cases do the findings display no effect which includes one that sought to convey safety instructions to workers via slogans in an informational campaign (Saarela, Saari & Alltonen, 1989 **[A-I]**). Admittedly, one could question whether this was a true training effort. Since the bulk of reports come from scientific journals, it could be alleged that these impressive results supporting a training effect could be a product of a bias toward publishing work showing positive findings. The consistency of the findings, however, given fairly similar training approaches for addressing the same or different agent hazards, is reassuring as is the fact that other types of reports (government documents, thesis studies) yield similar results.

Table 2: Methods Used in Training Interventions

Hazard Agent (No. of Studies)	Work Setting —At Risk Groups	Methodology— Evaluation Conditions				
		Basic Design	Training Target —Thrust	Variables Assessed	Post-Training Measures	Other Considerations
INJURY (21 Studies)	Hospital Manufact Wkrs Warehousing Mining Paper Mill Food Process Maintenance Construction Shipbuilding Laboratory Simulation Fishing	[3] Post Test [3] Pre/Post [1] TimeSer [4] Post/Ctr [3] Pre/Pst/Ctr [7] MultBsl	[18] FndtlWk Pract [1] HazRecog-Awareness [2] WkrPartic HazRecog [0] WkrEmpwr HazRecog	[6] TrngOnly [6] Trng & FdBk [4] Trng & GlSet/FdBk [2] Trng & Incentives [3] TrngMode Factors	[1] One/ShTm [4] Rep/ShTm [4] One/LgTm [12] Rep/LgTm	[1] Added publicity campaign to heighten interest; [1] Effect of presence of researcher. [2] Mgmt incentives –accountability
CHEMICAL (22 Studies)	Farmers Lumbermen Asbestos Wkrs Manufact Wkrs Hospital Wkrs Coke Oven Foundrymen Miners Public Emply Lead Wkrs Waste Site	9] Post Test [7] Pre/Post [2] TimeSer [2] Post/Ctr [1] Pre/Pst/Ctr [1] MultBsl	[8] FndtlWk Pract [4] HazRecog-Awareness [3] WkrPartic HazRecog [7] WkrEmpwr HazRecog	[15] TrngOnly [1] Trng & FdBk [0] Trng GlSet/FdBk [1] Trng & Incentives [5] TrngMode Factors	[5] One/ShTm [6] Rep/ShTm [4] One/LgTm [7] Rep/LgTm	[4] Variable mgmt support; [1] Training part of expanded awareness program [2] Small sample (<10)
PHYSICAL (10 Studies)	Outdoor Wkrs Radiation Firefighters Manufact Wkrs Maintenance Textiles	[2] Post Test [1] Pre/Post [2] TimeSer [0] Post/Ctr [4] Pre/Pst/Ctr [1] MultBsl	[7] FndtlWk Pract [3] HazRecog-Awareness [0] WkrPartic HazRecog [0] WkrEmpwr HazRecog	[4] TrngOnly [2] Trng & FdBk [0] Trng & GlSet/FdBk [1] Trng & Incentives [3] TrngMode Factors	[0] One/ShTm [3] Rep/ShTm [2] One/LgTm [5] Rep/LgTm	[4] Varied mgmt support –surveillance, [3] Other control actions to augment training.
ERGONOMIC (19 Studies)	Health Care Food Service Warehousing Assembly Work Firefighters Janitorial Maintenance Miners	[2] Post Test [5] Pre/Post [2] TimeSer [3] Post/Ctr [6] Pre/Pst/Ctr [1] MultBsl	16] FndtlWk Pract [3] HazRecog-Awareness [0] WkrPartic HazRecog [0] WkrEmpwr HazRecog	15] TrngOnly [1] Trng & FdBk [0] Trng & GlSet/FdBk [0] Trng & Incentives [3] TrngMode Factors	[5] One/ShTm [3] Rep/ShTm [7] One/LgTm [4] Rep/LgTm	[3] Workplace constraints to training [2] Training augmented by ergonomic enhancements [4] Varied mgmt support [5] Small sample (<10)
BIOLOGIC (8 Studies)	Hospitals Health Care Providers	[1] Post Test [5] Pre/Post [1] TimeSer [0] Post/Ctr [1] Pre/Pst/Ctr [0] MultBsl	[4] FndtlWk Pract [2] HazRecog-Awareness [1] WkrPartic HazRecog [1] WkrEmpwr HazRecog	[6] TrngOnly [0] Trng & FdBk [0] Trng & GlSet/FdBk [0] Trng & Incentives [2] TrngMode Factors	[3] One/ShTm [3] Rep/ShTm [0] One/LgTm [2] Rep/LgTm	[2] More accessible protective devices, [1] Rating compliance in evaluating performance. [1] Supervisor resistance

(2) As displayed in Table 1, for the few cases where training plans failed to yield positive results or achieved only partial success, most occurred in the ergonomic agent category. Training interventions for back injury prevention are primarily responsible for this result which is not surprising given the complex etiology of back disorders, lingering questions as to what constitutes safe lifting positions, and apparent constraints posed by workplace conditions to using learned lifting techniques. Studies by Carlton (1987 **A-IV]**) and Scholey (1983 **[A-IV]**) in particular illustrate how situational factors can complicate the transfer of safe lifting instruction. In Carlton's study, for example, kitchen workers in training sessions held away from their jobsites, learned and demonstrated ways for lifting trays that imposed less strain on the low back. Subsequent observations found that these types of lifts could not be performed in their work areas because the layout and obstacles made them assume awkward postures in handling loads of trays and the work pace precluded time to follow through on the acts required for risk reduction. Scholey reported that nurses could not transfer methods learned to ease the burden imposed in patient handling/lifting tasks because some patients refused to cooperate in moving to the edge of the bed or chair to facilitate the move. But even with these difficulties, the ergonomics agent category also shows some of the more substantial reductions in the frequency and cost of work related injuries reported as outcomes from training. Illustrative are reports of Hilyer et al., (1990 **[A-IV]**); McKenzie et al., (1985 **[A-IV]**); Schwartz (1987 **[A-IV]**) and Lepore, Olson & Tomer (1984 **[A-IV]**). As noted in Table 2 and APPENDIX A, because these studies did include ergonomic enhancements (i.e., improved workstation layout, tool redesign) along with training as part of the intervention, it is difficult to determine the specific training effect on these measures.

(3) Self-reports, especially knowledge gain and expressions of use in jobs, and objective behavioral measures predominate as outcome indicators in the training interventions. Positive findings of behavioral change from training such as adoption of safe work practices were in a number of instances coupled with reductions in injury, illness, and lost-days cost figures. Although suggestive, the reader is cautioned not to draw conclusions about a training specific effect on the latter indicators. One reason is that the instruction may have focussed on select (high risk) groups whereas the injury reports are for the whole organization. (Work reported by Lepore, Olson & Tomer, 1984 **[A-IV]** is an example). Some studies lacked proper control groups to rule out other factors that may have been responsible for the result on these types of outcome measures. Also, as one report notes (Reber & Wallin, 1984 **[A-I]**}), the findings may reflect changes in the manner of reporting mishaps during the intervention period. One deliberate effort to tie successful training outcomes such as improved work practices with reduced injury rates found that the adoption of the recommended work practices could only account for 25% of the actual reduction (Saari & Nasanen, 1989 **[A-I]**). In this study, worker training focussed on correcting housekeeping conditions believed responsible for an

excess number of injuries based on accident reports. Post training observations indicated reduced injury rates far greater than those that could be accounted for by increased compliance with the better housekeeping practices also observed. The authors speculated that the gains in housekeeping left increased capacity for workers to notice other potential hazards. Another effort (Sulzer-Azaroff et al., 1990 **[A-I]**) suggested that attaining certain targeted safe work practices was responsible for reductions in lost-time injuries but furnished no definitive analysis to show an actual cause-effect relationship.

(4) As noted in Table 2, the work settings/occupational groups as training targets for the intervention studies were diverse. Most major industry categories are represented by the entries- agriculture, mining, construction, manufacturing, transportation, public services. Some entries are in several agent categories owing to the variety of hazards encountered in such work environs. As examples, there are reports of training interventions for health care workers (public services) at risk to injury, ergonomic and biologic hazards; metal fabricators (manufacturing) at risk to injury, chemical, ergonomic and physical agent hazards; warehousemen (transportation) at risk to injury and ergonomic hazards, etc. Employing the OTA classification of training emphases, most of the intervention work reported here is directed to learning fundamental work practices, but the more recent reports show worker empowerment approaches to be popular as well. This is especially true in hazardous waste site training where labor groups in concert with universities are conducting such activities. (Examples are McQuiston et al., 1994 **[A-II]**; Luskin et al., 1992 **[A-II]**; Cole and Brown, 1996 **[A-II]**). Hazard recognition training is also noted as are efforts at worker participation in problem solving. A one-mode training approach has been used in most studies with pre/post types of evaluations performed on the trainee group to assess the effects. Actual training objectives and training approaches, however, are much more varied than this summary would suggest. For example, fundamental type training objectives range from appreciating the more typical safeguards, e.g., use of personal protective equipment, proper operation of machines, housekeeping needs in factory environments, to the more exotic techniques such as defusing potentially violent patients in a mental hospital. The training methods also depict an assortment of approaches—classroom lecture, on-the-job instruction, audio-visual techniques, simulators, demonstrations/role play— with sessions of varying length and frequency. (See APPENDIX A for details.) This wide array of training situations and conditions combined with the positive results underscores the versatility of the learning process. At the same time, it invites efforts to examine whether some factors or factor combinations are more critical than others to attaining successful training outcomes.

2. Intervention Data on OSHA Training Requirements/Guidelines

Ideally, to answer the question of whether OSHA training rules and guidelines have the intended benefit of reducing work related injury or disease, available documentation should offer evidence of:

(1) Training objectives presumably keyed to meeting the requirements of a specified OSHA standard.

(2) A training plan following the training guidelines mentioned earlier that can be reasonably implemented.

(3) A sound evaluation strategy that relates attainments of the training objectives to improved safety/health outcomes.

(4) Evaluative data reflecting increased knowledge/skills in hazard recognition and preventive measures, or commensurate worker actions resulting in reduced worker injuries or illnesses, or both.

The intervention studies reported in APPENDIX A and summarized above, though representing deliberate efforts to use training for hazard control purposes, provide only approximations to the ideal. Key limitations are:

Training Objectives*:* Many of the reports show training to be successful in improving protective actions or reducing a potentially hazardous condition but reference no particular OSHA standard or requirement pertaining to the situation posing a problem. Indeed, much of the work has been conducted by researchers who seek opportune targets for training that can yield results within a reasonably short time frame. Thus, positive results from training in these cases may or may not be considered as cogent support for any OSHA mandated rule. But having said this, the training plan in many reports does follow the OSHA guidelines in using a hazard analysis or injury reports to target the training needs and objectives, and in undertaking other steps for putting the plan in place. In this regard, the training effort may even be more relevant to the conditions under study. Perhaps OSHA rulemaking language calling for a training plan that defines and addresses site specific needs as opposed to one that dictates what they are a priori is worthy of discussion.

Training Effects/Outcome Measures: Whether the positive training effects reported such as knowledge gained, self-reports and/or actual observations of compliance with safe work practices can account for the reduced accidents, injury and lost days reported in several studies remain debatable. As already mentioned, the presence of other forms of hazard control introduced with training and uncertainties surrounding the basis for the accident/injury statistics argue against any such conclusions. Assessing the effects of training to reduce the risk of work-related chronic disease is even more problematic because of the long latency period needed to observe these kinds of outcomes. The reports on training plans under-

taken in response to the OSHA foundry and coke standard show benefits in terms of increased worker knowledge of hazards and their professing greater adherence to safe work practices and protective behaviors (e.g., Parkinson et al., 1989 **[A-II]).** Although plausible, evidence that these training benefits have or will result in reduced lung/cancer diseases or other occupational illnesses for these work groups may require 10 or more years of surveillance. Similarly, it is too soon to say whether hazardous waste site workers and emergency responders who report that they were better able to manage chemical spills after taking required OSHA training (McQuiston et al., 1994 **[A-II]**) will also show fewer cases of diseases owing to better control of the exposure hazards.

Evaluation Design: In almost half of the reported studies, training effects were determined by evaluations of post-training measures for a given group or through pre- and post-training differences or comparisons before, during, and after training again on the same group. Since many of the interventions took the form of research projects, there is no way of separating out elements of novelty and researcher effects, which could have influenced the outcomes in these subject groups apart from any training effect. Some studies used comparable but untrained groups as ways to control these kinds of factors. Still, as noted in Table 2, other factors were present during the course of the evaluation, factors whose effects could not be accounted for in the results reported. In this regard, a variety of management actions were noted that deserve particular mention. For example, in one set of studies, they played roles in reinforcing and sustaining the learned behaviors (e.g., Zohar & Fussfeld, 1981 **[A-III]**). In other cases, supervisors were themselves the trainees and used to spearhead and effect the hazard control practices subject to evaluation (McKenzie et al., 1985 **[A-IV]**; Maples et al., 1982 **[A-II]**). As part of the training effort reported in other studies, supervisors were directed to increase their surveillance (Millican et al., 1981 **[A-III]**), or consider staff compliance in performance evaluations (Lynch et al.,1990 **[A-V]**). In still other reports, the authors indicate management's indifference to the training objectives (Fox & Sulzer-Azaroff, 1987 **[A-I]**). Being linked with management, these actions and other more subtle ones probably had profound effects on the evaluations which could not be sorted out because of the lack of suitable control groups or other confounding conditions.

There were other design weaknesses as well. Table 2 shows that more than half of the studies measured post-training effects less than 3 months after the instruction ended or only once after a longer interval of time. Thus, questions as to the durability of the reported effects, or possible intervening events affecting the longer term measures can be raised. Several studies did consider these issues with the results being somewhat gratifying (Zohar, Cohen & Azar, 1980 **[A-III]**; Hopkins 1983 **[A-II]**). In a few cases the subject groups were too small to make generalizable conclusions, and others assigned workers to training conditions on a non-random basis which could question the representativeness of the findings. Nevertheless, the sheer number of positive results found in so many different settings suggests that training effects are real even though the appraisals do not meet the more rigorous scientific standards.

Practicality Considerations: Given the success of the many intervention efforts noted in this report, there is the issue of whether the training plans under evaluation would be doable as a general practice at the worksite. The techniques employed in some studies to effect success were most elaborate. One example was the University of Kansas work (1982 **[A-II]**) in defining fundamental safe work practices and housekeeping measures as training objectives, and proceeding through formal instruction, practice trials plus incentives to establish worker compliance. But in targeting similar needs, the training plans in other reports seem almost incidental, confined to a brief session or two to define safe and unsafe practices. Having workers establish goals for conformance with safe practices when at the jobsite and provide feedback as to progress being made to the workers appear to be the more critical elements in the success of this approach. Studies by Reber & Wallin (1984 **[A-II]**), Fox & Sulzer-Azaroff (1987 **[A-I]**), Komaki, Barwick & Scott (1978 **[A-I]**) offer such examples as does an extensive review by Sulzer-Azaroff, Harris and McCann (1994). Provisions for goal setting and feedback as part of worksite training would not appear to be that formidable. Reports of training beyond learning fundamental work practices accent worker participation, active learning-type experiences using problem-solving exercises or other forms of instruction that show cogency to conditions found at one's workplace. In this regard, the merits of a learner-centered plan to address safety and health problems along with learning experiences that promote worker activism to effect improvements at their worksites have become emphasized. And, indeed, first results from evaluating this approach in hazardous waste site training programs appear promising [McQuiston et al., 1994 **[A-II]**, Luskin et al., 1992 **[A-II]**; Cole & Brown, 1996 **[A-II]**). However, these findings are based on self-reports and thus have some limitation. Feasibility problems have also been noted. For example, needs to cover the subject matter of the course as well as to infuse empowerment ideas within usual time periods allotted to training mean that some topics get little treatment (Luskin et al., 1992 **[A-II]**). Another problem is the growing diversity of the workforce; this imposes added challenges in training approaches which stress worker inputs, group discussions and shared experiences. Cultural/language differences, among other factors, may be inhibiting (Cole & Brown, 1996 **[A-II]**). Two intervention studies reported in this review suggest ways for accommodating to language differences (Barnett et al., 1984 **[A-II]**; Weinger & Lyons, 1992 **[A-II]**). But perhaps the more important point is that training programs must be flexible in order to adapt methods and expectations to different working conditions and worker groups.

In summary, evidence for the effectiveness of OS&H training based upon the intervention studies reviewed above suggest the following observations:

(1) Taken as a whole, there is substantial documentation showing how training can meet objectives of knowledge gain, behavior change for improving worker health and safety. Reductions in work injuries and medical costs may also be noted in conjunction with these changes but evidence to show actual linkage or dependency remains to be ascertained.

(2) Because the intervention work does not address specific OSHA rules, the merits of specific training requirements can't be judged. On the other hand, the literature illustrates the benefits of training in meeting a variety of site-specific health and safety needs and objectives.

(3) Successful training outcomes in enhancing worker knowledge and control of workplace hazards and conformance with safe work practices depend greatly on extra-training or post-training environmental factors. Included in the latter are management's role/actions in favoring conditions which enable the knowledge gained from training or learned behaviors to be readily transferred to the jobsite. A proposed safety and health program standard as currently drafted by OSHA (OSHA, 1996) recognizes the merit of using a systematic approach to workplace safety and health. In doing so, management actions aimed at reinforcing training objectives along with other elements are duly noted.

The intervention literature on training in OS&H appears to be a collection of demonstration studies, some stronger in design than others in making a case for the benefits of a training approach (or in a few instances its shortcomings). As noted, more definitive analyses are needed to show how the outcomes of training relate to observed changes in injury or illness incidence. Also, and to be mentioned in a later section, certain factors critical to the learning process and post-training results, such as the length and frequency of the instruction, remain to be addressed in a more systematic way.

Even with all of the above uncertainties and qualifications, the array of evidence showing training-type interventions to effect positive changes in workplace safety and health remains formidable. Clearly, OS&H training can make a difference in reducing risks from workplace hazards. Rather than debate the issue of whether training is worthwhile, it would appear far more productive to determine what training procedures and related considerations are most crucial to optimizing its effects. Further support for this position comes from reviewing other sources of data bearing on the role of workplace training which are described below.

D. Training Data from Studies on Afflicted Workers

1. Bureau of Labor Statistics Work Injury Reports

A second level of information pertinent to answering questions about the value of job safety and health training may be derived from worker injury record data or investigations of occupational accidents resulting in injury or fatalities. Indications that significant numbers of those affected didn't recognize hazards or lacked for knowledge of fundamental safe work practices could suggest training shortcomings as a factor in the occurrences. During the years 1978 to 1990, the Bureau of Labor Statistics conducted 20 surveys of workers injured on the job. The surveys focussed on specific injuries and/or on those resulting from high risk job opera-

tions. The workers sampled were drawn from workmens' compensation cases in 26 states where awards were made during select reporting periods for the injuries in question.

Using mail questionnaires, information was gathered on demographic factors, working conditions at the time of the injury event, use of personal protective equipment and extent or nature of safety training.

APPENDIX B describes the survey samples and includes extracts of the findings from 19 of 20 BLS survey reports reflecting worker responses to questions dealing with training issues. (One of the BLS reports [falls on stairs] did not include any training questions). The column entries are self-explanatory and cover the essential training-related data found in the surveys. The shaded entries are meant to suggest a serious training deficit for sizeable percentages of the afflicted workers. The authors hasten to note that this is purely judgmental; other readers may have different views about what is and is not noteworthy.

Table 3 summarizes the findings of APPENDIX B, reproducing in part those entries which suggest real or possible gaps in the job safety/health training as reported by the injured workers. For each of the 19 surveys listed, worker responses reveal at least one form of an apparent training deficit or a related problem. All but one injury category have at least two gaps and nine have three or more. "Limited coverage", meaning the percentage of those injured who lacked for any safety training, or had no training specific to their job needs, is the most frequent entry followed by "policy/action lapses" used to address training gaps after injury occurrence. "Content lacking" entries in Table 3 mainly referred to insufficient instruction in fitting, use, or limits of personal protective equipment issued workers. The "inexperience factor" was included in the listing insofar as it warrants even greater concern for adequate training. Entries here show that from 22% to as many as 78% of the affected workers had no more than 1 year's experience at the time of injury; for several categories more than 15% were injured within the first 6 months at the job. Fewer entries are noted in the "refresher needs" column because 13 of the 19 surveys did not include items about the time of the last safety training. Of the six surveys that did, percentage of injured workers with training more than 1 year old exceeded 50% in four of the six cases, and was above 25% in another.

Table 3: Summary of Possible Gaps in Job Safety/Health Training as Noted in Bureau of Labor Statistics (BLS) Work Injuiry Reports

Worker Injuries Surveyed	Nature of Limitation				
	Limited Coverage	Content Lacking	Refresher Needs	Inexperience Factor	Policy/Action Lapses
Ladder Injuries	59% lacked training on ladder use	66% lacked training on how to inspect	Training for 50% over 1 year ago		
Scaffold Injuries	26-35% not trained in scaffolding tasks		Training for 71% over 1 year ago		
Welding/Cutting Injuries	30% learned job safety “on their own”		Training for 69% over 1 year ago	26% injured <l yr at job; 16% <6 months	
Power Saw Injuries	39% learned job safety “on their own”			44% injured <1 yr at job; 19% <1 month	
Head Injuries	32% lacked training on “hard hat” use				41% believed no corrective actions
Foot Injuries					>75% not wearing safety shoes when hurt- against policy
Eye Injuries	20% no training on safety eyewear use				20% noted eyewear enforcement only after injury event
Facial Injuries	60% untrained in use of face shields, welding helmets				56% not wearing face shield at time of injury
Injuries from Servicing Jobs	61% untrained in lockout procedures		Lockout training for 32% over 1 yr ago	38% hurt <1 yr at job; 22% <6 months	76% did not know policy on lockout
Lifting/Back Injuries	51% not informed on lifting procedures	95% not informed of lifting aid devices			40% believed no corrective action
Hand/Arm/Finger Injuries-Amputations	59% not informed of protective measures	23-27% uninformed on safety gloves use		10% injured doing work for first time	50% believed no corrective action
Injuries from Oil/Gas Drilling		21% believed training failed to cover injury causing task			15% unaware of hazards
Injuries in Logging Work	51% had no safety training			22% hurt <1 year at job; 13% <6 months	14% unaware of hazards; 15% misjudgments
Injuries from Falls from Elevations	75% received no training in fall protection				22% unaware of fall hazards; 43% need safer job methods
Laborer Injuries in Construction	33% had no safety training; 26% none for task re injury	>75% uninformed on health hazards (asbestos)		74% hurt <1 year at job; 50% <6 months; 12% injured first day	14% noted gaps in hazard awareness; 21% need for safer methods

Table 3 *(Cont'd)*: **Summary of Possible Gaps in Job Safety/Health Training as Noted in Bureau of Labor Statistics (BLS) Work Injuiry Reports**

Worker Injuries Surveyed	Nature of Limitation				
	Limited Coverage	Content Lacking	Refresher Needs	Inexperience Factor	Policy/Action Lapses
Injuries in Warehousing	48% no safety training; 46% none at task re injury			21% hurt <1 year at job	41% believed no corrective actions
Injuries in Longshoring			Last training for 59% was 3 years ago		Variable enforcement of safety rules
Chemical Burn Injuries	67% uninformed on protective measures				17% unaware of hazards; 12% wrong equipment
Heat Burn Injuries	55% uninformed on protective clothing	19% uninformed on policy re protection		35% hurt <1 year at job; 19% <6 months	25% safer work methods

Taken as a whole, Table 3 suggests many training inadequacies that may have contributed to the injury occurrences. However, the self-report nature of the data set, the possible bias of workers in avoiding any semblance of blame, and the lack of any confirmatory observations raises questions about drawing such a conclusion. Other data sources were sought to provide added clarification. These are summarized in the next section.

2. Investigative Studies Acknowledging Training Needs and Effectiveness

Several studies have focussed on training issues directly or indirectly in the course of investigating workplace hazards and related risk factors for disease and injury. Those offering training-specific data are reviewed here to furnish added information bearing on the question of the efficacy of training in this context. The studies reference the injury, chemical, and ergonomic hazard agent categories and are presented in that order.

Injury Investigations: As part of a NIOSH-supported epidemiological study of workplace fatalities, Manwaring & Conroy (1990) reported the results of on-site investigations of 55 confined-space incidents where 88 workers lost their lives. Through interviews with co-workers and company officials, data were obtained on the conditions surrounding the events, and applicable company safety policy and employee training. This was augmented by information contained in reports from the medical examiners, OSHA compliance officer, responding emergency medical services personnel. Analyses of the 55 incidents to establish possible patterns to the occurrences or common factors revealed that in only three events did workers receive any training in confined-space safety. In these three cases, two supervisors and two workers died, three of whom had received the training. Further testifying

to an apparent lack of training among other factors, no testing of the confined-space atmosphere was done before entry in any of the events, nor were confined spaces labeled with appropriate warning signs. Also few events gave evidence of confined-space ventilation prior to entry and no formal space entry authorization procedure was in place. Indications of the wrong type or improper use of respirators were also noted. The authors used the findings to stress the need to increase worker understanding and awareness of confined space entry through development and implementation of confined-space entry procedures and worker training. Poor implementation of training procedures was still evident in a later NIOSH report which summarized the data gained from a greater number of confined-space fatality investigations (NIOSH, 1994).

A similar NIOSH investigation of 201 electrocution-type incidents with 217 worker fatalities also suggested training deficits as a contributing factor but the available data were not as convincing as that shown above for confined spaces (Casini, 1993). In these cases, laborers, who typically received minimal training, showed the highest number of fatalities (42 of the 217 victims). But not far behind were linemen (40 of the 217 victims) who generally received extensive training in electrical safety. A total of 180 victims did receive some typical on-the-job training, in many cases from small employers. This investigation raised questions as to the adequacy of the training, and mentioned needs for more structure and ways to demonstrate that the workers understand the hazards and can carry out recommended safety measures.

Tan et al. (1991) interviewed 41 hospitalized patients who were being treated for hand injuries sustained at their workplaces. The interview took place shortly after the patients were admitted and gathered information on the nature and extent of the patient's training plus factors such as length of job service, description of the circumstances of the injury event. Regarding the latter, rollers, guillotines and chain saws were the machines commonly involved; most workers were unable to give a specific reason for the injury. Twenty-one patients had no job training and 20 had either formal or supervised on-the-job training of variable length. Three weeks of training was noted for the majority of workers. To determine whether training could have prevented the injury, patients having training were compared with those who had none in terms of the time each spent on the job before the injury occurred. The results showed little differences between the two groups. Indeed, 3 workers with training were injured on the first day and 7 were hurt within 12 weeks of starting their jobs as compared with 8 untrained workers who injured their hands during the same period. The authors questioned the adequacy of training in light of these results.

Chemical Hazard Investigation: Bryant, Visser & Yoshida (1989) collected questionnaire data from 165 hospital workers involved in ethylene oxide (EtO) sterilizing work. They found from 20% to 40% of the respondents to suffer from headaches, eye/skin irritations, and sore throats attributed to the exposures. Other

symptoms reported were nausea (19%), running nose (16%), shortness of breadth (15%), and drowsiness (20%). Included in the questionnaire were items asking about the amount of training, which for the sample ranged from less than 1 hour to more than 1 day. In more than one-third of the cases first aid was included, and use of protective equipment (i.e., gloves, gowns, masks) while working with EtO. Environmental samples of EtO were collected during each sterilizer task for the 18 hospitals which employed the 165 hospital workers. Correlational analyses showed amount of training time and use of protective equipment to each bear an inverse relation to the prevalence of reported symptoms; however, only a few of the symptoms showed a significant decrease. Moreover, the expected decrease in exposure levels from the use of protective clothing did not cause users to report fewer symptoms of short-term irritation. Indeed, 80% of the workers still complained of one or more symptoms despite exposures within current OSHA regulatory limits.

Ergonomic Hazard Investigations: Snook, Campanelli & Hart (1978) analyzed questionnaire returns from insurance agents who provided data on the latest compensible occupational back injury case in their workload. A total of 191 cases were described; the data included information as to onset of back pain, previous back injuries, act at time of injury along with selection and training procedures the employer was using to reduce the risk of back injury. Lifting/pushing tasks when implicated in the injury were rated in terms of percentage of population who could safely perform the same act without overexertion, and were the tasks used to supply job design or ergonomic reference data in the evaluation. The cases were separated in terms of the presence or absence of various techniques of selection (medical history, low back X-rays), whether or not training in safe lifting techniques was given, and whether the jobs rated below or above the 75% limits of overexertion risk. Neither training nor any of the selection techniques were found to have any significant differential effect on the numbers of reported cases. Only the job load variable proved significant. The authors concluded that selection or training approaches were not effective controls for low back injuries.

Green and Briggs (1989) conducted a questionnaire survey of 514 keyboard operators in a university workforce to determine the benefits of adjustable work station furniture—furniture used to alleviate postural discomfort as well as other ergonomic problems. The respondents included those who were classified as sufferers or nonsufferers of repetitive strain from keyboard work based upon symptoms previously associated with overuse injury. The questionnaire items sought information related to the adjustability of different components of the user's workstation (i.e., desk, chair, monitor), instruction received on how to make such adjustments, and the adequacy of both the instruction and the adjustability features for ensuring comfort. In addition to questionnaire data, anthropometric measures were taken on a subsample of the sufferer and nonsufferer groups on seated postures, specifically popliteal and elbow-rest height. Related to training and though recommended, a full-scale educational program to inform operators on use of the

workstation and strategies for relieving discomfort was not followed; rather advice on use of adjustable workstations was handled by issuing circulars diagramming proper positions to the users, and by small seminars and demonstrations run by the safety officer at the request of individual departments.

Respondent data indicated that sufferers had more negative perceptions of the equipment. Significantly more sufferers constantly readjusted the workstations (70% vs 43% for nonsufferers), could not get comfortable (35% vs 18% for non-sufferers), and were more likely to report insufficient adjustability (50% vs 20% for nonsufferers). The anthropometric data found chair heights not in accord with guides distributed. The authors believed that these problems were due to the lack of appropriate information being given to the operators. Almost 40% of the respondents could not recall receiving any guidance on how to adjust their workstations. Only 12% noted the literature distributed by the university; the most common source of information (64%) was from other persons with no formal ergonomic training. The authors concluded that there is a great need for training and/or information on workstation adjustment among keyboard operators, and that the preference for verbal instruction is greater than for printed forms of instruction. Given the widespread use of fellow workers as sources of information, it was also suggested that supervisors as well as keyboard operators be trained to cover new employee needs.

3. Appraisal of Training Data of Afflicted Workers

   The BLS work injury reports combined with the NIOSH findings on confined space fatalities and the problems seen in the postural discomfort/workstation adjustment survey strongly suggest that training deficiencies can contribute to these outcomes. This further supports the need for OS&H training. Yet, some workers who received training in these and the other studies cited in this section were still afflicted. Could the quality of training account for this result? That is, were sound training practices used? Did they, for example, follow the OSHA guidelines noted earlier? Even if they did, could other workplace factors (see Figure 1) have been present to nullify efforts to reduce injury or disease risk through training? Only two of above reviewed reports mention the instruction process. One found distinct weaknesses (Green & Briggs, 1989), and the other described nothing more than the length of training and whether it was formal or supervised “on-the-job” instruction. (Tan et al., 1991). Details of the training plan are sparse or non-existent in most of the above work.

In summary, workers without any OS&H training would appear at high risk for workplace injury or illness. Where training is given, the adequacy of the procedures in use becomes the issue. For this purpose, and like the intervention studies reviewed earlier, factors and conditions associated with effective OS&H training need to be ascertained.

In amplifying this point, OS&H training practices presently conducted throughout U.S. work establishments have not been examined to determine their adequacy in addressing known hazards and compliance with regulatory standards. One effort, limited to a small sample of companies engaged in waste site management, did in fact find many to be deficient in meeting existing OSHA training rules (Cole et al., 1994). The intervention studies summarized earlier cannot offer representative data since they were primarily demonstration efforts and special programs; they are not the norm. Although a new, independent survey would be ideal, much information characterizing OS&H training is already collected but remains buried in various databanks and report files that exist within NIOSH (e.g., Health Hazard Evaluation Reports, National Occupational Exposure Survey databank) and OSHA (e.g., compliance officer inspection reports). Systematic efforts to extract and assemble training related data from these sources could do much to provide a status statement on OS&H training practices and critical points.

E. Training Factors in the Context of Other Worksite Programs and Activities

1. Training in Successful Occupational Safety and Health Programs

As already mentioned, hazard control programs include a variety of activities, training being one that is interwoven with others in efforts to minimize risk of work related injury and disease. Attempts have been made to isolate factors in such programs—factors which are important to achieving these goals. For this purpose, the safety program practices of companies differing significantly in their injury experience have been compared and other studies have analyzed hazard control efforts among employers who have achieved exemplary safety performance records. Of relevance to this literature review was whether there were any data to show if the training practices noted in these programs made a difference in safety performance or contributed in a unique way to the success experiences reported. Of the literature in this area, the studies noted below were most notable in terms of examining training differences, among other practices, in contrasting high- and low-accident workplaces.

NIOSH Studies: During the period 1975–1979, NIOSH published several reports resulting from a project aimed at defining factors in successful occupational safety programs. The project comprised three phases. The first was a questionnaire survey of the safety program practices of 42 pairs of companies in one state that were matched in type of industry, workforce size and locale but differed by more than two-to-one in recorded injury rate (Cohen, Smith & Cohen, 1975). The second phase comprised site visits to a sub-sample of the above group to verify and observe more closely apparent differences between the pairs that could explain the differential injury rate (Smith, Cohen & Cohen, 1978). The third phase used both

mail questionnaires and site visits in collecting information from five companies recognized as having outstanding safety records based on total numbers of hours worked without a disabling injury (Cleveland et al., 1979). This third effort sought added confirmation of the findings from the previous two phases. Data collection for all phases focussed on such factors as management's commitment to the program, job safety training, safety incentives, hazard control measures, accident investigation/reporting procedures, and workforce characteristics. The general finding concerning training was that early indoctrination of new workers in safe job procedures with follow-up instruction to reinforce the learning was most frequently linked with successful safety performance. Formal classroom instruction versus on-the-job training or the use of varied instructional techniques were less notable considerations. The significance of training as compared with other program practices in accounting for safe performance could not be established. It is important to note, however, that management commitment factors both in these studies and others appeared to be the dominant or controlling element (Cohen, 1977).

Bureau of Mines Work: Peters (1989) summarized a number of studies supported largely by the Bureau of Mines dealing with organizational and behavioral factors associated with mine safety. Included were descriptions contrasting training practices and related miner knowledge in several surveys comparing high and low accident rate mines. The following were among the more notable observations:

(1) New miners in high-accident mines were less informed as to how to do their jobs than those in low accident mines.

(2) Lack of training in proper use of safety and health protective equipment was more frequently cited as being an important reason for miners not using the devices in high-accident mines.

(3) Having specific training in how the electrical system works; dealing with hazards such as coal dusts, gases and noise; and how to use tools, equipment was especially prevalent in the low-accident mines.

The Peters report noted that training for managers and supervisors produced significant improvements in mine safety and cited intervention studies demonstrating its effectiveness. One such study (Fiedler et al., 1984 **[A-I]**) is described in the collection of intervention work listed in APPENDIX A. This study found that the introduction of a structured supervisor training program accenting leadership style and skills in human relations or one stressing team-building and group problem-solving were each linked with reduced rates of injury and reduced MSHA citations at the mines under study.

Three observations about training derive from these NIOSH and BOM studies. The first is that training differences do exist between workplaces with good and poor safety records, but their overall importance remains to be ascertained. The second

is that the differences seem relative, i.e., greater or more deliberate efforts are made to train, and to commit supervisor time and resources in the workplaces with better safety records. The third and related to the second is that supervisor training in how best to deliver and reinforce safe work practices seems crucial to the overall training effort and the success of the hazard control program. Somewhat at variance to this last point, one intervention study found that using external instructors to directly train employees was superior to a train-the-trainer approach in implementing aspects of a hazard materials information system in a large sample of companies (Saari et al., 1994 **[A-II]**). The differences between the two approaches, however, were least significant for companies with other well-established safety and health program practices. This suggests again, as shown in Figure 1, that training effectiveness depends greatly on other variables which complicates efforts at its assessment.

2. Implications of First Aid Training.

Several OSHA rules (e.g., 29CFR Part 1910.151(b); Part 1926.21(b)) require that persons be trained to render first aid in the event that workers are injured and in need of treatment to maintain life, reduce suffering, or prevent the condition from becoming worse until more expert help arrives. Although one could argue that even these forms of instruction need to be evaluated as to their efficacy, there is evidence to show that workers who have first aid training tend to have fewer workplace injuries than those who lack for this type of training. Miller & Agnew (1973) first reported these findings which were confirmed later in more thorough evaluations by McKenna & Hale (1981; 1982). The importance of these results for this exercise is twofold: First, it documents that certain types of workplace training, though having other objectives, can apparently generalize and benefit workplace health and safety performance. Second, it suggests that melding first aid training with other requirements for OS&H instruction may have a reinforcing effect on the desired hazard control objective. The Miller and Agnew and McKenna and Hale studies offer speculations as to interactions between first aid and regular job safety training. These are contained in the summary of their work noted below.

Miller and Agnew (1973) analyzed frequencies of accidents as reported for workers in five different Canadian work establishments over time periods ranging from 3 months to 3 years. For each workplace, workers trained in first aid, whether on a voluntary basis or as a requirement of the job, were found to have fewer injuries than those who did not have the training. Miller and Agnew speculated that worksite regulations and actions taken for hazard control in combination with the first aid instruction produced an increased safety consciousness in the workforce.

McKenna & Hale (1981; 1982) compared worker injuries in two factories for 1-year periods before and after the completion of first aid training. The training was given in two 2-hour sessions and covered the usual topics (i.e., treatment of asphyxia, shock, poisons, wounds and bleeding, fractures, etc.). This instruction

was administered to one group of volunteers (the "experimental group") who before the training had worse injury records than a "control" group of workers matched by job, age, sex, and job- specific experience. Following the training, the experimental group showed a marked reduction in the injury rate as compared with the changes observed for the control group. Interview data collected 6 months before and 6 months after the training revealed no differences between the trainees and control workers in hazard awareness. When compared with the control group, however, the trainees did show shifts in attitudes and beliefs about accidents and injuries believed due to the first aid instruction. The major change was that the trainees regarded more accidents as being preventable and felt more responsibility for taking preventive actions. On this basis, McKenna and Hale suggest that the first aid training served as a personal motivator for adopting safe work practices and improving workplace safety conditions.

3. Worksite Physical Fitness/Exercise Training

Health promotion programs, though directed to lifestyle as opposed to workplace risk factors, can encompass training and education in areas that may have some add-on benefits to occupational hazard control objectives. Physical fitness training and exercise, in particular, through its goals of building muscle strength, maintaining joint flexibility and range of motion, reducing fatigue, increasing blood flow to stressed areas, is seen as a way to increase one's endurance or capacity to handle physically stressful job demands (Genaidy, Gupta & Alshedi, 1990). Efforts to apply this form of intervention in job situations where other measures are not feasible have been reported. The study of Hilyer et al. (1990 **[A-IV]**) described in APPENDIX A offers one such example. In this instance, back, shoulder, knee flexibility exercises were introduced to reduce musculoskeletal disorders among firefighters in a city fire department. These disorders were the leading type of on-duty injuries reported for these municipal workers. A 2-year post-training appraisal found that although firefighters engaged in this exercise showed no differences in the occurrence of sprain, strain, or muscle tear type injuries from their nontrained cohorts, it did reveal less severe injuries, speedier recoveries, and reduced medical costs. A similar attempt by Silverstein et al. (1988 **[A-IV]**) to apply exercise training to relieve risks for upper extremity disorders from assembly and packaging jobs requiring repetitive, forceful motions, and awkward postures was not as successful. The latter type of situation would appear more amenable to other forms of intervention such as job redesign and changes in work station layout. These should be the priority hazard control measures.

Worksite health promotion programs that can enhance not substitute for required forms of hazard control is a laudable goal. Some intervention efforts combining elements of hazard protection and health promotion are beginning to appear but do not allow one to determine the contributions of each to the overall gains from the intervention. Shi (1993) for example, reported on a back injury prevention program for California county workers who in recent years experienced the highest preva-

lence of back pain and back-related injuries. The program combined 1) education on backache, weight control; 2) back safety training focussed on body mechanics and hazardous lifting tasks, 3) physical fitness emphasizing participation in regular exercises and 4) ergonomics improvements (e.g., making safety equipment more accessible, improving seating/work stations for easing postural stress, rearranging storage for minimizing materials handling burdens). Comparisons of questionnaire and medical claims data taken before and 1 year after the program showed significant reductions in individual risk factors for back pain (as much as 64% in the highest risk group), a decline in actual back pain experience (10-12%), and a 12% drop in medical costs per claim (versus a 15% increase in other groups not involved in the program). Although encouraged by the overall results, Shi admits that the study design is incapable of differentiating the individual effects of the program's components.

VII

Verifying Critical Elements/Program Factors for Effective Occupational Safety and Health Training

So far the focus of this review has been on whether training as required in various OSHA standards is efficacious in terms of reducing work-related injury and disease based on data found in the literature. The findings from the training intervention work offer the strongest support for such outcomes but as already noted there are several qualifications. In particular, the targets of most of these training studies have not been OSHA rules per se, and the evaluative measures, which do show gains in workplace safety/health knowledge and practices, may fall short in accounting for actual reductions in injuries or illness should they also be reported. Yet, the intervention studies do show the potential for training to produce positive health and safety effects and do include measures that can serve as surrogates or risk indicators for the bottom line injury/disease experience.

The question to be addressed here is whether certain factors stand out as crucial to attaining a successful training outcome in targeting some occupational safety and health objective. Two approaches to answering this question are taken. One verifies the importance of certain of the steps contained in the OSHA voluntary training guidelines by using empirical examples taken from the literature under review. A second considers evidence for singling out instructional factors as well as extra-training factors for their importance to the training experience and benefits to hazard control.

As a preface to this discussion, two points should be made. First, that the bulk of the training intervention literature reveals many studies showing positive results despite differences in training plans, targeted objectives, and evaluation methods. Indeed, few approaches seem ineffective which hampers the search for critical factors. Second, few efforts have been made to independently vary certain learning variables or conditions affecting the transfer of training to the jobsite so as to study their effects on outcome measures. This too nullifies a basis for rating the significance of key factors. Nevertheless, both in the intervention studies and other literature noted above, there are suggestions of controlling factors or at least factors that deserve more systematic evaluation to establish their importance. They will be noted along with other apparent needs in sorting out critical determinants in effective OS&H training.

A. Examples Supporting OSHA Voluntary Training Guidelines

Examples of training situations with outcomes confirming the merits of the OSHA voluntary training guidelines or, at the minimum, offering ways for implementing them are found throughout the literature cited in this review. Those thought to best illustrate or capture the essential points of the different guidelines are described in this section, classified by the particular guideline of reference.

OSHA Guideline: *Determining if Training is Needed, i.e., whether a (hazard control) problem is solvable by training.*

Exhibit #1: Cohen & Jensen (1984 **[A-I]**) found their training plan, though effective in having operators adopt certain targeted behaviors critical to safer use of fork-lift trucks in warehouses, could not effect a change in one that required them to do more driving in reverse and to continuously look over their shoulders when doing so. Inquiry revealed that this change was resisted for two reasons: First, lift trucks were propane-powered and driving in reverse caused the operators to breathe in more of the noxious fumes. Second, constantly looking over one's shoulder is unnatural and an uncomfortable posture to endure for prolonged periods. Use of battery-powered vehicles and installation of rear view mirrors would appear reasonable alternatives for alleviating these problems.

Exhibit #2: Carlton (1987 **[A-IV]**) instructed food service workers in the straight back/bent knee method of lifting and to recognize high risk workstyle factors (horizontal extension, spinal torque) for back problems. This group proceeded to score higher in a biomechanics assessment of their performance in a novel task of lifting/lowering trays of varying weight when compared with an untrained group. No such differences were found, however, for their on-the-job behaviors. Thwarting the transfer of this training were worksite obstructions that forced the workers to assume awkward positions, to engage in much extended horizontal lifts, and to subvert other actions aimed at risk reduction. Clearly, unless work station layout problems are addressed in this context, the benefits of training for reducing materials handling hazards will not be achieved.

OSHA Guideline #2: *Identifying the Training Needs, i.e., what the worker is expected to do with regards to job hazard control and in what ways.*

Exhibit #1: A University of Kansas study (1982 **[A-II]**), via industrial hygiene surveys, mapped out areas in plants manufacturing fiberglass products where concentrations of styrene, a hardening agent used in the production process and a known neurotoxin, were found to be the greatest. For these identified areas, job analyses plus interviews with managers and workers were then conducted to determine what tasks and worker actions could most influence exposure levels for work performed at these locations. This effort yielded a control plan, which

included needs to effect worker compliance with 11 work practices and 20 housekeeping measures aimed at reducing exposure levels. Samples of prescribed work practices included avoidance of high exposure areas when there is no need to be present (e.g., keeping one's head out of a spray booth except when spraying), and exploiting existing engineering controls (e.g., spray toward exhaust ventilation). Housekeeping measures sought to reduce added sources of styrene exposure through covering waste cans of excess styrene coatings and locating them near exhaust ventilation ports; and covering floors with disposable material that could be changed frequently to reduce overspray buildup. These and other proposed actions constituted well-defined targets for the training program set in place. Compliance to the work practices and housekeeping measures as developed in this program resulted in significant reductions in styrene exposures to the workforce under study.

Exhibit #2: Sulzer-Azaroff et al. (1990 **[A-I]**), in instituting an injury prevention program in a large plant, reviewed accident and injury records, interviewed safety personnel, managers, and workers, and made direct observations to determine "hot spot" work areas and high risk job behaviors that would be candidates for intervention efforts. The diversity of ongoing operations dictated a subdivision of work units, each having its own set of safety performance targets, with the program starting in those groups where the bulk of accidents were happening. Safety performance targets included personal behaviors (e.g., wear eye protection; sort no more than one or two boards at one time), as well as behaviors affecting conditions (e.g., keep aisles clear; load carts without overhang). Targeted safety actions following training were achieved in all high risk units with some showing reductions in injury rates. All units showed a reduction in lost time cases and savings in medical costs.

OSHA Guideline #3: *Identifying Goals and Objectives, i.e., specifying what the instruction is to attain in clear and measurable terms.*

Exhibit #1: Zohar, Cohen & Azar (1980 **[A-III]**) undertook a program to promote awareness of the damaging effects of noise on hearing among workers who were at risk and to increase their motivation to wear ear protection. In addition to a conventional hearing conservation lecture, workers took hearing tests before and after their workshift to demonstrate how much temporary hearing loss occurred on days when they wore and did not wear ear protectors. Use of the protectors minimized such loss and the audiograms of those who routinely wore protection were posted along with those who didn't to show the benefits of the protection. The nonusers' audiograms showed profound permanent hearing losses which further accentuated the program's endgoals. This approach yielded a 50% increase in ear protector usage.

Exhibit #2: Bentley & Horstman (1986 **[A-II]**) instructed lumbermen on how to reduce dermal contact/exposure to timber coated with chlorophenol, a preservative agent with toxic properties. For this purpose, workers were counseled on the need to use gloves/aprons, apply barrier creams, wash hands at breaks, and each day wear freshly laundered clothes offering maximum skin coverage. Through adding a fluorescent agent to the chlorophenol, workers could see the extent of skin contact under ultraviolet light resulting from their work tasks. Workers were encouraged to view themselves under this light source during the course of training to show how the various protective practices helped to reduce their exposure. Post-training results for these workers found significant decreases in metabolites reflecting reduced exposure to chlorophenol which was attributed to the protective measures taken.

OSHA Guideline #4: *Developing Learning Activities, i.e., instruction that emphasizes cognitive or physical skill factors commensurate with job demands and that is offered in ways that facilitate transfer to the actual job situation.*

Exhibit #1: Michaels, et al. (1992 **[A-II]**) composed a training plan and materials for increasing worker awareness/knowledge of chemical hazards. The target groups were public employees engaged in shop work of various kinds (e.g., vehicle maintenance, carpentry/plumbing, printing) and in construction, custodial tasks. Materials were developed through site visits, interviews with workers to assess their health/safety concerns, and determinations of amounts of chemicals in use at site-specific locations. Consultations with the city OS&H office were also included. The training course covered the Hazard Communication Standard, how to read material safety data sheets, and to gain information on toxic chemicals, routes of entry, symptoms, health effects, and control measures. Information was tailored to fit exposures associated with different job titles and was offered to workers and their foremen/supervisors in such departments. Besides lecture, exercises used throughout the instruction allowed workers maximal input in identifying hazards of greatest concern, and in enabling them to work through various control options and the means for putting them in place. Post-training results indicated follow-through efforts at the workplace to correct a number of shortcomings in OS&H program practices.

Exhibit #2: Hultman, Nordin & Ortengen (1984 **[A-III]**) sought to train janitorial workers in ways to relieve increased stress on the spine caused by frequent forward bending in mopping tasks. The training plan comprised three 30- to 45-minute sessions. The first covered simple anatomy of the spine, muscle physiology and biomechanics. The second and third sessions included slides of workers performing tasks that put stress on the low back akin to mopping work. Techniques to relieve this loading were demonstrated (e.g., bend knees in mopping rather than flex the back; place water bucket on chair or leave on cart to avoid deep forward bending when bucket is placed on floor). The workers were given opportunities to practice them under the supervision of the instructor.

Workers were found to spend more time in upright, less stressful condition following training.

OSHA Guideline #5: *Conducting the Training, i.e., the use of an instructional format that promotes active learning with frequent feedback to mark progress, invites worker inputs and takes account of differential worker experience or skill levels to create/sustain motivation.*

Exhibit #1: Saarela (1990 **[A-I]**) used a small group approach for effecting improved housekeeping practices in a shipyard where poor housekeeping was implicated in about one-third of the injuries reported. A steering committee of top management plus safety staff provided information and the basic aims of the program. Planning details and implementation were left to small groups (4-13 persons) formed within each of 13 departments. Each group consisted of the department chief, supervisors and workers. The groups, with the help of a facilitator, met to discuss housekeeping problems within their own areas, how they could be remedied, and once corrected, how they could best be maintained. They arranged training seminars for the total department staff to illustrate improved housekeeping practices, set goals for their attainment, established a system for monitoring compliance, the results of which were posted. All of the groups adopted measures for better housekeeping, the more active ones showing the greatest gains in terms of their department staff perceiving improvements in housekeeping practices. Overall, there was a 20% reduction in injuries associated with housekeeping during the intervention year.

Exhibit #2: Weinger & Lyons (1992 **[A-II]**) sought to increase farm worker knowledge of the health effects of pesticides, symptoms of poisoning, routes of entry, ways to minimize exposure, first aid procedures, and how to effect better preventive measures against these types of hazards. Needs assessment took account of pesticide exposures as documented by visits to farms and observations of work practices. Focal group discussions were held with farmers to consider content issues, best modes for conducting training as part of a learner-centered approach to address the information, behavioral skills, problem-solving objectives of the training. In some cases, training was in Spanish because of the Hispanic makeup of trainees. Techniques adopted for actual training used role-playing, case studies, and demonstrations to dramatize issues and facilitate worker participation. Post-training measures gave indications of lesser exposures to pesticides among trainees. Also greater activism on their part to report unsafe, hazardous working conditions.

OSHA Guideline #6: *Evaluating Program Effectiveness, i.e., the training program should have an evaluation plan built in at the outset and include measures for assessing whether it has met its objectives, preferably indicators reflecting both knowledge and application.*

Exhibit #1: Lynch, et al. (1990 **[A-V]**) instituted an infection control training program in a medical center. Its aim was to enhance staff (clinical, technician, housekeeping) knowledge of infection control and adoption of more stringent barrier practices for body substance isolation. Program content emphasized regular use of gloves/masks/gowns, compliance with upgraded containment/disposal methods in handling specimens, laundry, and trash, and special handling of highly infectious patients. After meetings were held with departments to iron out problems in adopting new procedures, fifty 45-minute lecture and slide sessions were held to inform staff and to maximize attendance. The pre-post training approach used to evaluate the intervention included three measures: 1) a questionnaire to ascertain knowledge, attitudes, and self-reports of infection control actions practiced before and after the training session, 2) appropriate glove use for patient contacts and procedures as recorded by independent observers for periods of 2 to 3 months before and after the training, and 3) use of microbiology lab reports monitoring marker organisms of nosocomial colonization and infection for the year before and 3 years after the intervention. Post-training results indicated significant increase in knowledge of infection control and glove use, plus a decline in the nosocomial colonization and infection rate.

Exhibit #2: Reber & Wallin (1984 **[A-I]**) divided the 11 plant departments that accounted for 95% of the company's injury reports into 3 groups. One group received safety training only; another, training plus goal setting; and the third, training plus goal setting plus feed-back according to a staggered schedule. The treatments were introduced at different times for the three groups, enabling one group to serve as a control for the other in assessing the impact of the training plus other factors. The training itself consisted of 10 weeks of daily 45-minute safety discussions of safety rules with slides showing safe and unsafe ways of doing job tasks specific to the departments involved. Training effects were evaluated by several measures. One consisted of a quiz given midway (5-week point) during the training to ascertain worker knowledge of safe practices. A second was direct observations of whether the workers were adhering to safe practices using a checklist to score their performance during baseline, training, goal-setting, goal setting plus feedback phases of the program. In addition, the overall injury incidence rate and lost time injury incidence rate was calculated for the 3 years before the training intervention and for the year during which it was implemented. Results showed that workers could identify over 80% of the safe and unsafe conditions at the midpoint of the training and that training, goal setting, and feedback were each found to increase the frequency of observed safe behaviors. Adding feedback to goal setting provided the greatest increase in safety performance. The lost time injury rate decreased post-training, but the authors noted

that this effect must be treated with caution because of changes in the safety recordkeeping procedures during the 1980-84 period.

OSHA Guideline #7: *Improving the Program, i.e., shortcomings observed in evaluation data such as knowledge gaps, deficient performance levels, poor retention would dictate needs to revise training plan to improve its efficacy.*

Exhibit 1: Cole et al. (1988 **[A-II]**) found that a 14-step procedure for donning a self-rescuer breathing apparatus (SCSR) could not be performed proficiently for effective use in mine emergencies even after years of hands-on training and annual refresher demonstrations. A simplified 3+3 step plan was developed encompassing the major objectives of isolating the lungs and preparing for escape and was structured to overcome the position/sequence problems and slowed response noted in using the 14-step procedure. Instructor modeling of the new procedure and repeated opportunities for each miner trainee to don equipment and observe others doing the same was used for training with the new method. Evaluations comparing the donning times and sequential errors for the new method versus the old procedure found the revised one reduced overall donning time by 50% and displayed smoother, less confused or interrupted actions. As noted in this report, this demonstration of a revised and apparently improved training procedure was done in training rooms above ground and did not take account of the dark, muddy/wet floors and of the dirty/battered SCSR devices found in actual underground conditions. One company trained its miners with the new procedure both above and below ground and found more errors below ground which slowed donning time. Recommendations were made to train miners to high levels of mastery above ground and provide for frequent refresher exercises to overcome this problem. (See also report by Vaught, Brinch & Kellner (1988 **[A-II]**) on this point).

Exhibit #2: Karmy & Martin (1980 **[A-III]**) sought to increase ear protector use in a complex of eight plants, each averaging noise levels of 90 dBA. For this purpose, the eight plants were divided into four treatment groups: One group was educated to use ear protection through a poster campaign followed by a videotape presentation; a second was given repeat audiometric tests at 7 to 12 month intervals; a third was given both the educational message and repeat audiometry; and the fourth served as a control. Comparisons of ear protector use in the various plant groups were made over 22 months. The treatments began for the audiometry at the 3-month point; at the 10th month point for posters; and at the 15th month for the videotape. The control group showed little change throughout this period in percentage of workers wearing ear protection. The introduction of the posters resulted in a 15% increase in ear protector use, which then dropped in one plant until the videotape showing. This caused a 25% jump in use, which again trailed off. Repeat audiometry by itself increased ear protection by 40% in one plant and 20% in a second with little signs of regression. Repeat audiometry plus education attained a maximum 30% increase in ear protector use with indications of continued growth. The results here suggest that the educational offering by itself did

not produce durable change. The education plus repeat audiometry did so but could be improved if the workers were given feedback regarding the results of their hearing tests to indicate the benefits of the ear protection. No such provision was made in the program, and a recommendation for doing so was offered.

B. Evidence for Distinctive Training and Extra-Training Factors

The aforementioned OSHA guidelines offer structure to an OS&H training program and the exhibits with the guidelines above give meaning to the various elements based upon empirical work. But inherent to the training process and attainment of its objectives are a number of factors of consequence barely touched upon in the guidelines as described. These include variables such as size of training group, length and/or frequency of training, manner of instruction, trainer credentials, and training transfer factors among others. Motivational considerations and extra-training factors such as management's interest in and concern for worker safety also need to be addressed as they would appear to greatly modify the learning experience and its outcome.

The reports summarized in APPENDIX A plus others cited in the literature offer some data for making statements as to the significance of these types of factors, or suggest the most promising conditions for achieving successful training results. Such evaluative findings are summarized in this section. As will be noted, evidence based on systematic manipulations of acknowledged variables, at least for the OS&H literature reviewed here, is available in only a few cases. Other evidence for significant factors tended to emerge by finding them common to a number of studies with apparent similar influences on the training outcomes. Table 4 lists different factors with capsule statements tying together evaluative information from different reports cited in APPENDIX A to indicate the nature of their effect on or importance to the training process or its outcome.

One immediate impression in viewing Table 4 is that the documentation identified with different factors is quite disproportional. Specifically, the information base on size of group and length/frequency factors is relatively small whereas that shown for motivational/promotional factors is much larger with the others falling in between. The supportive findings for the statements conveying the importance of the size of group and frequency/length of instruction to training are further limited by the fact that they were derived from post hoc data analyses in the few cited reports, not from efforts to vary parameters of each factor to ascertain their significance. Only the statements for mode of training and motivational/promotional factors rest on studies that in the main, employed systematic or controlled manipulation of conditions as a basis for deriving the statements. Evidence of the influence of other factors (as contained in the statements alluding to them) was based on the listed studies yielding similar results for the same factor; this was largely based on all-versus-none treatment comparisons.

Another impression is that many of the statements agree with or are consonant with well-known concepts in the psychology of learning and motivation (Deese, 1952; Ruch, 1963). For example, captured in the statements in Table 4 are the benefits of increasing training time, repeated practice sessions, opportunities for more individualized instruction (through lower student-to-teacher ratios), and active rather than passive learning experiences focussed on conditions that can promote transfer to the areas in need. Learner-centered, small-group problem-solving approaches are newer variants of these ideas. The intent is to prompt student actions to make needed workplace health and safety changes. Similarly, the statements on goal setting, feedback, and token rewards to help learn safe work practices and to strengthen such acts in the workplace are elements of the behavior reinforcement literature in psychology. Some extensions or illustrations of certain factors are also contained in the statements. That supervisors or foremen are key players in ensuring safe and healthful workplace conditions is well taken. Perhaps the trainer role further impresses upon the supervisor or foreman the importance of safety at work and ways to meet production goals without having to forego hazard control measures or permit workers to take undue injury or health risks. As noted, added supervisor/foremen instruction in both workplace safety and health as well as interpersonal relations enhances this result.

There is evidence too of how training is needed to complement or augment engineering or physical hazard control measures to realize successful safety and health outcomes. As described by the studies cited in this context, training is not only necessary to ensure proper use of the control systems that are in place but also to enable workers to adopt work methods that take greater advantage of their capabilities for providing protection. Cohen (1987) provides other examples of how worker actions and behaviors can affect different elements of worksite hazard control systems, all of which could be objectives in a training program.

With one exception, the evidence underlying each of the statements for the various factors in Table 4 reflects data obtained from more than one hazard target and from different work settings or worker groups. (The exception is one statement in Ancillary Factors where all reports dealt with biologic hazards and hospital personnel. Even here, however, the hospital personnel differed in makeup—some being professionals (clinical staff), and others in support services (laboratory technicians, janitorial/laundry workers). This suggests some generalizability of the findings though, as already mentioned, the actual amount of documentation varies greatly from factor to factor (and from factor statement to factor statement).

Table 4: Summary Evidence for Distinctive Training/Extra Training Factors

Factor	References [Hazard/Setting]	Evaluative Findings
SIZE OF GROUP	Saarela, 1990 [Injury A-I/Shipyard] Robins et al., 1990 [Chemical **A-II/** Manufacturing]	Small groups (fewer than 25), having in common similar jobs, work locations, exposures to the same hazards, offer more opportunities for effective learning experiences leading to and/or undertaking actions having positive effects in risk reduction.
LENGTH/FREQUENCY (Other Temporal Issues)	Parkinson et al., 1989 [Chemical **A-II**/Coke Oven Plants]	Attendance at multiple training courses dealing with the recognition of workplace hazards and control actions does increase knowledge of the risks and also worker self-reports of taking more precautions to reduce apparent exposure hazards.
	Robins et al., 1990 [Chemical **A-II**/Manufacturing]	Increases in trainer time per unit group of workers and use of more frequent, short training sessions offered at the beginning of the workshift suggest more favorable outcomes in terms of worker recognition of hazardous exposure situations, increases in safe work practices, and prompting actions aimed at improving other hazard control measures.
MODE OF TRAINING	Saarela et al., 1989 [Injury **A-I**/Shipyard] Borland, et al., 1990 [Physical **A-III**/Telephone Linemen] Karmy & Martin, 1980 [Physical **A-III**/Manufacturing]	Informational campaigns involving posters, video presentations, pamphlet distribution by themselves produce some gains in assimilating fundamental safe work practices, but based on behavioral indicators, the effects are typically small and may not be durable.
	Leslie, Jr. & Adams, 1973 [Injury **A-I**/Lab Simulation of Punch Press] Rubinsky & Smith, 1971 [Injury **A-I**/Lab Simulation of Grinder] Bosco & Wagner, 1988 [Chemical **A-II**/Auto Workers] Vaught et al. 1988 [Chemical **A-II**/Miners] Goldrick, 1989 [Biologic **A-V**/Hospital]	Comparisons of written instructions/lecture versus slide/videotape presentations versus actual “hands on” or interactive video techniques for learning proper work methods and fundamental safe work practices, based on knowledge tests or behavioral indicators, tend to favor the latter, more active forms of instruction.
	McQuiston et al., 1994 [Chemical **A-II**/Hazardous Waste Sites Brown & Nguyen-Scott, 1992 [Chemical A-II/Hazardous Waste] LaMontagne et al. 1992 [Chemical **A-II**/Sterilizing Work] Michaels et al. 1992 [Chemical **A-II**/Public Facilities] Weinger & Lyons, 1992 [Chemical **A-II**/Farm Workers] Cole & Brown, 1996 [Chemical **A-II**/Hazardous Waste Sites]	Training approaches using role play, case study to depict workplace safety and health problems, and practice in working through solutions/obstacles to improved hazard detection and control by means of individual and organizational change processes show signs of being successful based on reports of trainees, which note their actions in overcoming shortcomings in their company hazard control program.

Table 4 *(Cont'd)*: **Summary Evidence for Distinctive Training/Extra Training Factors**

Factor	References [Hazard/Setting]	Evaluative Findings
TRAINING-TRANSFER	Chhoker & Wallin, 1984 [Injury **A-I/**Machine-Welding Shops] Cohen & Jensen, 1984 [Injury **A-I/**Warehousing] Fox & Sulzer-Azaroff, 1987 [Injury **A-I/**Paper Mill] Komaki, Barwick & Scott, 1978 [Injury **A-I/**Bakery] Ray, Purswell & Schlegel, 1990 [Injury **A-I/**Aircraft Maintenance] Reber & Wallin, 1984 [Injury **A-I/**Equipment Manufacturing] Saarela, 1990 [Injury A-I/Shipyard] Saari & Nasanen, 1989 [Injury **A-I/**Shipyard]	Contrasting illustrations of safe with unsafe work practices taken from actual job situations facilitates the learning of fundamental safety and housekeeping rules; however, effective carryover to the work settings in question depends on motivational-management influences found in both the training and post-training environment.
	Scholey, 1983 [Ergonomics **A-I**V/Hospital Wards] St. Vincent, Tellier & Lortie, 1989 [Ergonomics A-IV/Hospital] Stubbs et al. 1983 [Ergonomics **A-I**V/Hospital]	Evidence of achieving well-trained safe work practices through training may fail to yield benefits in the workplace because of physical constraints or other conditions that interfere with their expression.
MOTIVATION-PROMOTIONAL FACTORS	Chhoker & Wallin, 1984 [Injury **A-I/**Machine-Welding Shops] Cohen & Jensen, 1984 [Injury **A-I/**Warehousing] Fox & Sulzer-Azaroff, 1987 [Injury **A-I/**Paper Mill] Komaki, Barwick & Scott, 1978 [Injury **A-I/**Bakery] Komaki, Heinzmann & Lawson, 1980 [Injury **A-I/**Vehicle Maintenance] Ray, Purswell & Schlegel, 1990 [Injury **A-I/**Aircraft Maintenance] Reber & Wallin, 1984 [Injury **A-I/**Equipment Manufacture Saari & Nasanen, 1989 [Injury **A-I/**Shipyard] Sulzer-Azaroff et al., 1990 [Injury **A-I/**Telecommunications Equipment] Univ. of Kansas, 1982 [Chemical **A-II/**Fiberglass Product] Maples et al., 1982 [Chemical **A-II/**Chemical Processing] Zohar, Cohen & Azar, 1980 [Physical **A-III/**Metal Product Manufacture] Alavosius & Sulzer-Azaroff, 1985,1986 [Ergonomics **A-IV**/Infirmary]	Setting performance goals reflecting compliance with targeted safety and health behaviors and/or providing feedback to mark progress in both the training and post-training environment are effective methods for attaining successful training results. Of the two, feedback looms as a more potent, influential factor. The two in combination offer maximum impact.

Table 4 *(Cont'd)*: **Summary Evidence for Distinctive Training/Extra Training Factors**

Factor	References [Hazard/Setting]	Evaluative Findings
MOTIVATION-PROMOTIONAL FACTORS	Univ. of Kansas, 1982 (also Hopkins et al., 1986) [Chemical **A-II**/Fiberglass Product] Fox, Hopkins & Anger, 1987 [Injury **A-I**/Mining] Zohar & Nussfeld, 1981 [Physical **A-III**/Weaving Mill]	Use of token rewards for reinforcing safety actions in the course of OS&H training and their subsequent application in the workplace also found effective. Question: Does interest in awards per se cause distractions from the true intent of the training?
	Sulzer-Azaroff et al., 1990 [Injury **A-I**/Telecommunications Equipment] Lynch et al., 1990 [Biological **A-V**/Hospital]	Success in OS&H training and its transfer to the workplace can also be driven by making workplace safety and health practices an element in one's performance evaluation.
TRAINER QUALIFICATIONS	Maples et al., 1982 [Chemical **A-I**/Chemical Processing] Lepore, Olson & Tomer, 1984 [Ergonomics A-IV/Air-Space Technology] McKenzie et al., 1985 [Ergonomics **A-I**V/Telecomm. Product Assembly]	Training supervisors/foremen in hazard recognition and means for control not only appears to produce positive workplace changes, but as trainers and change agents, to raise the level of worker safety performance. Best results for train-the-trainer approaches occur where other safety and health program practices are well established.
	Fiedler et al., 1984 [Injury **A-I**/Mining] Fiedler 1987 [Injury **A-I**/Mining] Smith, Anger & Uslan, 1978 [Injury **A-I**/Shipyard] Sulzer-Azaroff et al., 1990 [Injury **A-I**/Telecommunications Equipment]	Supervisor/foremen training for improving skills in team building, resolving personnel/conflict issues and performance management has the potential for effecting improved safety performance among the rank-and-file workforce.
	Askari & Mehring, 1992 [Biologic **A-V**/Hospital] McCarthy, Schietinger & Fitzhugh, 1988 [Biologic **A-V**/Health Care] Saari et al., 1994 [Chemical **A-II**/Manufacturing	Train-the-trainer programs targeting workplace safety and health concerns and focussed on ways to promote worker actions aimed at hazard prevention and control show promise based on follow-on experiences of those who received training; however, management's acceptance of workers as trainers looms as a possible impediment.

Table 4 *(Cont'd)*: **Summary Evidence for Distinctive Training/Extra Training Factors**

Factor	References [Hazard/Setting]	Evaluative Findings
MANAGEMENT ROLE	Ray, Purswell & Schlegel, 1990 [Injury **A-I**/Aircraft Maintenance] Saarela, 1990 [Injury A-I/Shipyard] Ewigman et al., 1990 [Physical **A-III**/Firefighting] Zohar, Cohen & Azar, 1980 [Physical **A-III**/Metal Product Manufacture] Zohar & Nussfeld, 1981 [Physical **A-III**/Weaving Mill] Cole & Brown, 1996 [Chemical **A-II**/Hazardous Waste Sites	The level of management support of workplace safety and health training and/or its application in the post-training job environment greatly affects the nature and durability of its impact.
	Sulzer-Azaroff et al. [1990 Injury **A-I**/Telecommunications Equipment] Lynch et al., 1990 [Biologic **A-V**/Hospital]	Initiatives giving hazard control program practices high priority and accountability measures for assuring effective efforts being undertaken at all levels of the workforce can do much to reinforce and sustain positive training outcomes.
	Fox & Sulzer-Azaroff, 1987 [Injury **A-I**/Paper Mill] Hopkins, 1983 [Chemical **A-II**/Fiberglass Product Manufacture]	Indifference on the part of management can extinguish gains from training and specific efforts at enhancing safety and health practices.
OTHER ANCILLARY FACTORS	Linnemann et al., 1990 [Biologic **A-V**/Hospital] Lynch et al., 1990 [Biologic **A-V**/Hospital] Seto, et al., 1990 [Biologic **A-V**/Hospital] Wong, et al., 1991 [Biologic **A-V**/Hospital]	Making required safety related materials and personal protective items more accessible and convenient for use can facilitate the training effort and ease the burden of complying with safe work practices when at the jobsite.
	Univ. of Kansas, 1982 [Chemical **A-II**/Fiberglass Product Manufacture] Cheng, Yang & Wu, 1982 [Physical **A-III**]/Ionizing Radiation Applicat.] Millican, Baker & Cook, 1981 [Physical **A-III**/Gas Diffusion Plant] McKenzie et al., 1985 [Ergonomic **A-IV**/Telecomm. Product Assembly] Parenmark, Engvall & Malmkvist, 1988 [Ergonomic A-IV/Product Assembly Line]	Worker training may be needed to complement engineering, physical, and ergonomic solutions to control workplace hazards or to otherwise enhance their capabilities for assuring maximal health and safety protection.

On the last point, Sechrest and Figueredo (1993) state that the literature on intervention research, of which training is a part, needs to pay more attention to variations in the strength of treatment factors and how they can alter outcomes as opposed to just a treatment versus no treatment (or control) approach. Frequency/length of instruction, one of the two types of factors where the literature in OS&H training proved sparse, would offer certain ways for varying the strength of a training intervention. The importance of the frequency/length factor cannot be stressed enough. It is the basis for defining refresher training needs as well as establishing the type of training regimen necessary to meet and sustain standards of performance in critical skill/emergency situations. Some research data on retention of job skill training over time (Sitterley, Pletan, & Metaftin (1974)) suggests that without practice, or for tasks seldom performed, high level job skills can deteriorate much sooner than anticipated (e.g., between 1 and 4 months for piloting aircraft or firefighting). Also that different skills degrade at different rates, e.g., losses for performing more complex, procedural tasks are greater than those for simpler or straightforward manual operations. In terms of retraining, the same studies found methods offering dynamic, pictorial representations of the task situation (i.e., movies, videotapes) are as effective as hands-on practice, although the combination resulted in the greatest recovery. Implications of these findings to retraining issues in OS&H are obvious. For example, it suggests that priority candidates for more frequent safety and health refresher training would be those procedures that are rarely used but are nevertheless critical when situations arise demanding appropriate action. Emergency events, which would fit this category, would justify frequent practice and drills to offset any loss in the knowledge and performance of actions to be taken. Reports by Cole et al.(1988 **[A-II]**) and Vaught, Brinch & Kellner (1988 **[A-II]**) discuss this need in connection with evaluating miner skills in donning the self-contained self-rescuer breathing device used in cases of mine fire and explosion. Similar needs for frequent drill may also exist for prescribed safety and health practices that are counter to natural behaviors or that add extra steps to task performance especially when the hazard risks are not that apparent. Procedures to ensure safe performance in confined space work and rescue actions would appear to fall in this category. For other situations, the basis for establishing training and retraining schedules is less clear. Presumably, criteria for determining such scheduling would take account of the complexity of the hazard control measures to be taught, the degree to which they are integrated into everyday work routines (and thus afford opportunities for practice), local and industry-wide injury and disease incident data for the work in question, among other considerations. The development of a decision logic for OS&H training that dictates selective scheduling of training and retraining when appropriate, not sooner or later or more or less frequent than required, would seem a worthwhile effort. As part of this exercise, it would also be important to acknowledge the kinds of retraining or refresher experience that can best sustain the desired outcome.

The motivational/promotional factors area in Table 4 shows the greatest number of citations. These entries reflect the major attention given to goal-setting and feed-back techniques as ways to promote the learning of safe behaviors during training. But

even more, these techniques are shown to reinforce and strengthen the occurrence of such acts in the post-training or actual job situation. Indeed, in many of these studies, the training seems incidental, merely taking the form of workers viewing right and wrong ways of performing various tasks, usually in one session. The real emphasis is given to monitoring worker compliance with the safe acts when at the jobsite and varying the nature of information feed-back to the workers who may have set up safe performance goals to further spur compliance behavior. The overwhelming results from these studies is that the feedback and/or the goal setting conditions effect safer workplace behaviors. This has prompted the conclusion that training by itself does not account for improvements in worker safety and health but that the positive consequences of such actions in the form of feedback indicating compliance or progress in meeting performance goals is responsible (Sulzer-Azaroff, Harris & McCann, 1994). One could argue in these instances, however, that worker training does not end with the one session illustrating safe and unsafe practices. That the follow-on monitoring and feedback provided to workers of their job actions can be interpreted as "on-the-job" training in establishing safe workplace behaviors. The line between training and extra-training factors is difficult to draw and underscores the point noted in Figure 1 of the interactive nature of training with other workplace influences.

The literature on performance feed-back and use of incentives as a means of altering behavior in general and workplace safety in particular have been the subject of separate reviews (Lindell, 1994; Balcazar, Hopkins & Suarez 1985; McAfee & Winn, 1989). Conditions that favor consistently positive results are those where the feedback includes a tangible reward, is administered by a supervisor, and occurs at least biweekly. Private versus public feedback, individual versus group performance feedback appear about equal in effectiveness. Lindell (1994) explains how workers' respond to feed-back and incentive programs in different ways depending on their expectations regarding the outcomes of their actions, and the values they see in the rewards offered. Both he and McAfee & Winn (1989) stress the need for a conceptual framework for understanding relationships between knowledge of results, incentives and safe behavior and offer some formulations in that regard.

Feed-back/incentive programs would appear generally applicable to any situation where workers can be readily observed to assess their compliance with the prescribed safety procedures. Although the near uniform success of these interventions in enhancing safe worker behavior and safer workplace conditions is impressive, one reservation is that withdrawing the feedback or incentives could result in a reversion back to earlier problematic conditions. How management reacts to the gains and takes steps to maintain them can be critical. Instituting new policies stressing safe as well as productive job efforts, increasing supervisory training in and attention to safety conditions, and fostering greater contacts between management and employees on safety issues have been shown to be supportive. Taken together these kinds of actions create a positive safety climate in an organization that can do much to consolidate the benefits of the intervention effort.

Incentive awards raise concerns apart from the economic and delivery factors that might be involved. Those awards that remind one of how it was achieved are best, yet may be the least attractive to workers who would prefer cash or gift certificates offering more options to fit their wants. Group awards may decrease the size of the individual award but provide for peer pressure to maintain safe performance. This, in itself, can have negative consequences because the group might pressure workers to avoid reporting their injuries. As Lindell (1994) notes, "There appears to be little guidance in the research literature or agreement among practitioners regarding the optimum design of incentive plans" (Pg. 224).

In discussing alternatives for effecting the transfer of safety training to the job, Ford & Fisher (1994) suggest that techniques used for other behavior management purposes may have some utility. Reference is made to three different methods. One is a "buddy system" approach successfully used in smoking reduction; this pairs trainees to reinforce the need in each other to maintain learning, offer advice, and be alert for signs of relapse in themselves or their buddy. A second is use of "booster sessions" as an extension of training wherein periodic face-to-face contact between trainee and trainer is required. In weight control studies, inclusion of booster sessions at 2-,3-, and 5-week intervals induced a greater percentage of maintained weight loss than did the absence of such sessions. The third is a relapse prevention method in which the trainees are exposed to situations posing obstacles to their trained skills and are led through exercises preparing them to cope with these difficulties. The latter approach, in design and objective, seems similar to work already reported in this review by Brown & Nguyen-Scott (1992 **[A-II]** and LaMontagne, et al. (1992 **[A-II]** embracing worker empowerment ideas. In these instances, trainees defined likely workplace obstacles to improved hazard control, including those posed by organizational factors. Through role play and case study examples the trainees learned ways to resolve them. As noted, first evaluations of these efforts gave encouraging results.

Table 4 suggests conditions for the various factors that favor effective training, reinforcement of behaviors once learned, and success in their transfer to the jobsite. The question of some factors and conditions being more important than others is not addressed and, in actuality, may depend on situation-specific circumstances. One could argue, for example, that size of group, length/frequency, and mode of instruction factors may be less important in training aimed at making workers aware of and observant of fundamental safety rules/housekeeping measures in jobs that are routine in nature, performed at fixed locations and under well-defined conditions. Under these conditions, the emphasis can be less on how the training is conducted than on those factors or conditions that can motivate continued adherence to such practices. In contrast, factors in how the training is administered can be a major concern where knowledge of hazard recognition and control measures plus safe work practices becomes more formidable because of varied job operations and/or uncertain, changing workplace conditions. This would suggest that training regulations be performance-based, allowing employers to develop a training plan that can accomplish the safety training objectives required for their job operations or worksites. At this stage,

and speaking in general terms, the statements on various factors noted in Table 4 coupled with the OSHA voluntary training guidelines offer aids in structuring an effective training program based on the current literature. At the same time, and as already mentioned, the knowledge base is not strong regarding certain factors underlying the training process, e.g., length/frequency of instruction. Added efforts to address these kinds of needs and others mentioned in the course of this review seem evident.

VIII

Summary

This review sought evidence from the literature to determine whether OS&H training requirements, as cited in Federal standards governing workplace conditions and operations, were effective in reducing work related injuries and illnesses. A secondary objective was to determine if the available documentation showed certain training factors or practices to be more important than others in producing positive effects on worker safety and health. Major sources of data used in this review were reports of training intervention efforts designed in whole or part to enhance worker knowledge of workplace hazards, effect compliance with safe work practices, and take other actions aimed at reducing risk of injury or disease. Surveys and investigative reports were also examined to determine whether training factors were implicated in the etiology of occupational injuries or disease or were considered significant to the success of those worksite hazard control programs showing exemplary safety and health performance. Still other sources for data were reports of worksite training directed to other needs but having apparent positive effects on workplace safety and health.

A. General Conclusions on Training Effectiveness

The literature reviewed in this report offers much direct and indirect evidence to show the benefits of training in ensuring safe and healthful working conditions. Data from the training intervention reports addressing major workplace hazards as encountered in a wide array of work situations is especially supportive. Findings are near unanimous in showing how training can attain objectives such as increased hazard awareness among the worker groups at risk, knowledge of and adoption of safe work practices, and other positive actions that can reduce the risk and improve workplace safety. There are data too from other types of studies suggesting that inadequate or lack of required safety training may have contributed to events where workers were injured or killed. While affirming the benefits of OS&H training, some limitations in the data sources were also noted bearing on the merits of current OSHA training rules in reducing work-related injury and disease. To enumerate:

1. Evidence to show how reduced injury, lost time and medical costs reported in the intervention studies resulted from training, measured in terms of knowledge gain and behavior indicators, was never clearly established. In some instances training was coupled to other forms of interventions so as to make attribution even more difficult.

2. Much of the training intervention work reported in the literature targeted site-specific problems. This afforded researchers opportunities to put into place various training and other strategies that could yield meaningful data in a relatively short time-frame. Many of these efforts did follow the OSHA voluntary training guidelines, and their apparent success in improving protective actions and safe work conditions demonstrate the value of such guidelines. On the other hand, the cogency of these data to any OSHA mandated training rule remains to be seen.

3. Successful training outcomes in the intervention studies appeared greatly influenced by management's role in and support of safety training, especially its transfer to the jobsite. Policies which favor opportunities for applying the knowledge gained from training or reinforce learned behaviors through incentives or other means produce optimum results. Although referred to as extra-training or post-training environmental factors, the above considerations seemed so central to achieving training objectives as to raise the issue of whether they deserve mention in OSHA regulatory language covering training requirements. They are not acknowledged in current training requirements. Separating these kinds of extra-training factors from training per se may be artificial; indeed, everyday experiences on the job are a form of continuing training with safety performance being shaped by management policies and supervisor/worker actions aimed at accountability. OSHA's latest draft of a proposed safety and health program standard emphasizes management actions to ensure effective training results as well as to realize other program goals.

4. Reports suggesting training deficits as factors contributing to worker injuries, health complaints, and workplace fatalities lack confirmation. That workers having received safety and health training are also afflicted indicates needs for ascertaining the essential nature or quality of the training offered and whether it meets OSHA requirements.

Even with these shortcomings, evidence that OS&H training can reduce risks from workplace hazards remains strong. Indeed, the issue is not so much whether OS&H training is worthwhile but what factors both within and beyond the training process can produce the greatest possible impact.

B. General Conclusions on Critical Training Factors

The literature reviewed in this report portrayed a wide array of training plans and activities, targeted objectives, and evaluation methods that would appear to offer a fertile basis for sorting out those factors or conditions most influential in affecting the training results. This intent was hampered by the fact that so many studies yielded positive training results regardless of which design and technique was used. Indeed, few actually manipulated or compared variables in systematic ways to assess their strengths to the training process. For this and other reasons, the statements below

about critical determinants of effective occupational safety and health training programs based on this review must be regarded as somewhat speculative.

1. Numerous examples illustrating the various steps contained in the OSHA voluntary training guidelines are found in the literature and show support for this approach. Various exhibits show how the intent of the guidelines can be met in realistic ways and have merit in framing and implementing an effective training plan.

2. Factors in the actual learning process, which were isolated in this review, included size of group, length/frequency of training, training mode, transfer, motivation, trainer qualifications, management role among others. Documentation was most extensive for motivational factors with evidence that feedback, goal-setting, reward incentives have near uniform success in facilitating safety instruction and the carry-over of such knowledge to the jobsite. In contrast, reports and information on size of group and length/frequency of training factors were greatly limited. The latter raises questions about training schedules for safety and health subject matter, and whether the timing for both original and refresher training is appropriate.

3. Factors and conditions favoring effective safety training and its transfer to the jobsite agree with or are consonant with what is known in the general scientific literature on the psychology of learning and motivation. Some refinements are also noted in finding apparent benefits from using supervisors or foremen as safety trainers, and evidence that effective operation of engineering or physical systems for hazard control can be dependent on training.

4. Whether some learning factors are more important than others may vary with situation-specific concerns. The literature suggests that factors influencing safety training focussed on fundamental safety rules and housekeeping practices for routine jobs require no elaborate instructional effort; rather the stress is on factors that can ensure the transfer to the jobsite. Safety training requirements addressing more complex job demands and uncertain work conditions would have to give more consideration to the learning as well as carry-over needs.

5. Even with the qualified answers given in this report to the question of critical training factors, the material presented should benefit users of the OSHA voluntary training guidelines in terms of supplying illustrations of how the different guidelines work in practice, and enabling users to recognize the role that certain factors or conditions can play in moderating the effectiveness of any such training effort.

C. Needs for Follow-on Work

This literature review has noted gaps in available information and other limitations which suggest needs for further efforts at answering the questions at hand. The following reiterates and elaborates those believed most essential.

1. The training intervention studies reported in this review and showing evident success in meeting their objectives were found wanting for several reasons. One was that most did not address OSHA training requirements found in any particular standard. A second was that most measured training effectiveness in terms of gains in safety knowledge or increased preventive actions; relationships between these measures and reductions in injuries or disease, if also reported, were not clearly shown. Other criticisms were the limited timeframe for studying the results of any training intervention and the site-specific nature of many efforts. These findings could question the generalizability of the findings. More relevant work offering a broader base for evaluation would seem indicated. In this regard, one approach would be to focus on the most prevalent types of injuries and diseases and the select industries or work operations where they occur. Applicable OSHA training requirements for those industries or operations would be noted along with the actual training practices being followed at different sites directed to those specific injury or disease risks. Differences in how the mandated training rules were met at the various sites selected for study, and apparent linkages between the training undertaken and specific injury or disease control measures would be analyzed to assess the effect of training and identify strong or weak practices, etc. This type of study has not been done.[3]

[3] A report received just after this review was completed comes close to this idea. Its intent was to show the benefits of mandated versus voluntary training for painters who face exposure hazards from toxic paint materials and coatings. Questionnaire data from painters in Alaska where training is mandated versus painters in Washington and Oregon where similar training is done on a voluntary basis showed important contrasts on issues not heretofore raised. Specifically, and as expected, mandated training increased the likelihood that all workers would be trained, regardless of union affiliation, or because of working for small shop employers. This was viewed as an important consideration inasmuch as nonunion and small paint shops were believed more likely to vie for jobs posing higher risk of toxic exposures. Further, it was noted that voluntary training appeared to attract only those painters who had undergone previous training. That is, painters with the least amount of previous training tended to forgo added training under the voluntary system. Information supplied by painting contractors in this survey also found that Alaska's mandatory training requirement did not elevate employers' safety and health expenditures when compared with similar costs for voluntary programs in Washington and Oregon. Although the report goes on to note how the Alaska training program improved respirator and fan use plus other self-protective measures against painting exposure hazards based on the questionnaire responses for those surveyed, data validating these benefits in terms of lesser work-related illness are not given. For more details see Wolford R, Larson M, Merrick D, Andrews M, Tillett S, Morris S, Keiffer M. [January 1997]. A comparison of safety-and-health training of painters in Alaska, Oregon, and Washington. The Center to Protect Workers' Rights, 11 Massachussetts Avenue, N.W., Washington D.C. 20001.

2. Related to the above proposal in a more general way, little information exists of how industry responds or has responded to various OSHA training rules and the quality of such efforts. Some information of this nature is certain to exist in data files of NIOSH, OSHA, and MSHA as a result of other programmed work undertaken by these agencies. Records from NIOSH Health Hazard Evaluations, fatal accident investigations, and the National Occupational Exposure Survey databank would be good sources to tap as would OSHA and MSHA Compliance Officer inspection files. Efforts to extract and assemble training related data from these files could provide a status statement on OS&H training practices. Depending upon the data actually available, one could determine the extent to which the training follows the OSHA voluntary guidelines or other frameworks and any resultant experiences in attaining hazard control objectives.

3. A major point in this literature review is that OS&H training is embedded within a larger overall hazard control program of an organization, and thus its effectiveness in reducing work-related injury and disease can depend on other factors. Aside from the instruction itself and motivational factors such as goal setting, feedback that reinforces the learning, and its transfer to the jobsite, there are engineering, administrative, and organizational practices that can also affect the training activity and its objectives. Top management commitment to workplace safety and health, supervisor/worker communications on safety and other issues, and accountability stressing both safe performance as well as productivity can greatly influence the degree to which the lessons learned in the training program can be transferred to the shopfloor. To examine which types of training practices by themselves or in combination with these other factors can yield the most positive effects will require indepth studies, and it is proposed that such efforts be focussed on those establishments with exemplary hazard control programs as demonstrated by their low injury/illness rates. The OSHA "STAR" companies in their Voluntary Protection Programs (OSHA, 1988b) would appear to offer a sample of suitable candidates for study.[4] Although seemingly repeating other work aimed at defining successful program practices, this proposal would look more critically at the training activities, both in isolation and in their interactions with other factors to define the dominant or controlling influences on the training outcomes. The endproduct of this work is envisioned as a series of case study reports describing the characteristics of effective training programs and ways to integrate them with other hazard control measures so as to produce the maximal benefit.

4. Other possibilities for assessing the importance of training could take the form of retrospective studies comparing differences in the level of training of workers who are injured on the job or afflicted with an occupational disease with comparable groups not so affected. The reports cited in this review give uncertain results as to

[4] "STAR" companies in the OSHA Voluntary Protection Programs must meet comprehensive safety and health program qualifications and maintain lost day injury rates at or below the national rate for that industry. Companies who apply for and receive "STAR" status are evaluated onsite every three years with annual reviews of their injury rates.

whether appropriate training could have prevented these occurrences. But as noted, one major drawback of these studies is the absence of more factual information on the extent or nature of the training actually received as it relates to the problem. Added efforts to determine whether training gaps or weaknesses can contribute to injury or disease incidents would be worthwhile. Critical to this work, however, would be the need to detail the training practices in place as well as other factors that could moderate their effects. Case-control or cohort approaches would offer ways for obtaining comparative data on affected versus nonaffected persons, given the need to separate out many nontraining factors that could be responsible for the differences.

5. In considering factors inherent to the training process, duration/frequency issues drew special attention. The OS&H literature contained few references dealing with this subject despite its significance to scheduling instruction, both for initial and refresher training purposes so as to ensure a maximal, durable effect. The skills training literature offers some ideas about major variables that should be weighed in deciding on an appropriate schedule, and these could be the starting point for deriving a decision logic to address workplace safety and health training objectives. For this purpose, it is suggested that workshops be convened to discuss this as well as other matters relating to the effectiveness of OS&H training. Invitees would include experts and practitioners conversant with job skill and OS&H training plus others engaged in basic learning research, program evaluation, health education, and organizational behavior representing both the private and public sectors. This would be one way to tap the diverse knowledge applicable to answering the questions raised in this report. In addition to the topic of a decision logic for training schedules, other items on a workshop agenda could include:

   - The adequacy of the current regulatory language on training requirements.
   - Future training challenges owing to changing workplace technologies/job demands and related hazards, worker demographics, emergent occupational injury/illness problems.
   - New training technologies and evaluation strategies for measuring training outcomes.
   - Desirability of merging independent training domains (skills training, OS&H training, health promotion).

Outputs from the workshop would be state-of-the-art information for training fulfilling its role in contributing to improved OS&H conditions, both now and in the future.

IX

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APPENDIX A

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

A-II. Control of Health Hazards—Chemical Agents

A-III. Control of Health Hazards—Physical Agents

A-IV. Control of Ergonomic Hazards

A-V. Control of Health Hazards—Biologic Agents

APPENDIX B

EXTRACTS FROM BUREAU OF LABOR STATISTICS (BLS) WORK INJURY REPORTS FOR DISCERNING REAL/POSSIBLE GAPS IN JOB SAFETY/HEALTH TRAINING

APPENDIX A

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
744 nurses attending 27 wards in 973-bed mental hospital subject to risk of inpatient assault. (Carmel & Hunter, 1990)	To train staff in techniques for defusing or otherwise controlling potentially violent acts by patients to limit the risk of injury.	Staff required to take 16 hours of instruction, as part of initial training plus 6-8 hours refresher training, every 2 years in managing assaultive behavior. While not detailed in the report, other sources indicate the training stresses verbal techniques for defusing potentially violent behavior and non-offensive physical ways to control or restrain violent acts by patients.	Data accessed from 1986 enabled authors to relate staff injuries from inpatient assaults to nurse compliance with training, and to wards serviced by staff showing a high versus low compliance with training.	None elaborated.	The rate of staff injury from patient violence in the wards with low training compliance in managing assaultive behavior (20/100 staff) was almost 3× the rate of those in the high compliance wards (7/100 staff). For nurses not having the training, 18.2% reported assault-type injuries as compared with 11% for those nurses who had the instruction. Similar comparisons for nurse CPR training did not show association with ward or nurse injury incidence; hence, the effect was content specific.	Although suggestive, authors admit that the association between training and reduced assault injury outcomes cannot be treated as cause and effect.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
58 male workers engaged in machine, boiler, and welding shop tasks in a plant manufacturing heat exchangers. (Chhoker & Wallin, 1984)	To promote worker conformance to 35 behaviors deemed critical to safe work performance.	A list of 35 critical behaviors was formed based on analyzing 5 years of accident reports, observing of plant operations, and National Safety Council (NSC) recommendations. Over a 6-week period, slides were shown contrasting safe work acts versus unsafe ones. A goal was established and posted for attaining 95% safe behavior.	After 5 weeks, workers were given a safety quiz in which workers were asked to differentiate slides of safe versus unsafe acts. In addition, a checklist of the 35 behaviors was used by independent observers to rate compliance of the workers 1–2 times per week before, during, and at various stages of post-training where feedback was given to the workers.	Following the training phase, feedback of safety performance as observed/rated on the checklist was posted and compared to the goal. This was done first on an every week basis and then every 2 weeks.	Percent (%) safe performance scores for the various phases of the study were as follows: o Baseline = 65% o Training/Goal Setting = 81% o Training/Goal Setting/Feedback (1 per week) = 95% o Training/Goal Setting/Feedback (l per 2 weeks) = 97% o Training/Goal Setting/Feedback withdrawn = 89% o Training/Goal Setting/Feedback reintroduced (1 per 2 weeks) = 94%	Results suggest the potency of feedback in reinforcing safe behaviors and their durability. Goal setting by itself has positive but lesser effects on safe performance. Training, goal setting, feedback as a package create optimum performance.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
96 operators of industrial lift trucks at two warehouse sites. (Cohen & Jensen, 1984)	To promote operator awareness and adoption of 14 specific actions critical to safer operator/vehicle use.	Focus was on 14 worker behaviors that could be observed, measured, and related to accident occurrences as defined by a task-hazard analysis. 5 training sessions (20-45 minutes long) were given on 5 successive days: 1 introductory, 3 instructional, and 1 practice/exercise. Slides were used to show incorrect/correct behaviors; Practice session had group grade performance of each trainee on a practice run.	3 observers counted frequencies of the correct/incorrect 14 behaviors as noted at 8 locations at each warehouse on a daily basis. At Warehouse 1, operators were divided into 3 groups: training only, training + feedback, and a control group that was trained only after 1st post-training evaluation. Study plan had monthly pre-training and post-training 1 & 2 phases, plus a retention phase that was 3 months after post-training 2. At Warehouse 2, all workers trained at same time and all received feedback.	All levels of management had input into the program and supported its development. Feedback supplied daily through verbal and posted summaries of group performance. All groups subject to training set an 80% goal attainment level.	For Warehouse 1, at end of retention phase and after all workers trained, overall decrease in incorrect acts was 44%. Training + feedback group showed best scores in post-training 1. At Warehouse 2, overall improvement in 14 behaviors was 70%. 12 of 14 target behaviors indicated clear improvements; 2 were resisted because they involved an uncomfortable posture, and exposure to exhaust fumes.	The effect of training to achieve safer work behaviors is clear. Question: Will it reduce accident/injury rate in lift truck operations?

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
500 soda-ash miners at 2 sites and 450 lead-zinc miners at 2 sites (Fiedler, Bell Jr., Chemers, & Patrick, 1984; also Fiedler, 1987)	To compare two approaches to management training. One involved organization development (OD), i.e., team-building and problem-solving; the other, a pre-packaged supervisory standard program (SP). Both aimed at improving productivity and safety performance.	OD approach stressed interactions at all management levels down to first-line supervisors and workers. Priority problems discussed and solutions developed for implementation. Four 45-minute meetings with miners held for their inputs. SP approach used 2 modules: one (6–8 hours) teaches leaders how best to exercise control fitting their own personality. The other, was in supervisory skills training (16 hours) to handle problems at an individual level. Videotapes, role play were used throughout instruction.	OD approach employed in one lead-zinc mine whose lost-time accident rate, MSHA citations, and sick-absenteeism were compared with miners in a second lead-zinc mine for 2 years, before and 14 months after the program. For SP method, comparisons were made between soda-ash mines under study and those for total industry on the above measures plus productivity figures 1 year before and 2 years after the training. Evaluations for 3 added years were reported for the soda-ash mines using the SP training method.	OD mines endured a 9-week strike during the last year of the intervention, which confounded productivity measures. SP mines underwent market decline in use of product and management changes, but program apparently retained support.	For OD method, injury incidence rate fell 51% in mines during 2-year post-training period, and was lower than the comparison mine whose rate remained the same. Citations showed a steady decrease whereas comparison mine showed marked fluctuation. Absenteeism dropped from 11% to 7% after training. For the SP mines, the injury rate dropped from 14 to 6 per 200,000 hrs of work, which met the industry average. Production was 7%–12% greater than the industry average; citations fell 85% after training. Follow-up data at the SP mine for 3 added years found a further drop in accident rates (3–4 per 200,000 hrs of work), and decreases in MSHA citations (less than 50 per year as compared with 340 pre-intervention).	Authors note that both approaches proved effective, but that the OD is more costly to implement. Efforts to explain away other factors that could account for the results are mentioned, i.e., introduction of performance evaluation systems. Authors believe convergence of results is reassuring. Interviews with managers also hold view that training was effective factor in improving mine safety and productivity.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
Uranium miners at one site numbering from 197 to 606 over a 13-year period of data collection; from 450 to 501 coal miners at a second site over a 12-year period. Lost workdays from mining injuries at both sites exceeded the national average by factors of 3 or better. (Fox, Hopkins, & Anger, 1987)	To comply with MSHA regulations in providing safety and health orientation to new employees, formal job training in hazard recognition, use/maintenance of protective equipment, and knowledge of emergency procedures and first aid. Provisions for required refresher training were also in place.	Initial training for new employees included both classroom and on-the-job training with refresher training for others at yearly intervals. Retraining undertaken for those assigned to different jobs. Formal training carried out by a safety and health training staff. Bi-weekly "tool box" meetings held by foremen to discuss close calls and hazard conditions needing correction.	Compare frequency rate of mining injuries, numbers of days lost, costs of injury/damage events during a baseline period of 2–5 years versus a post-treatment period of 11–12 years. The treatment was to reward employees monthly with trading stamps for injury- or damage-free work, the stamp awards being greatest for those in the most hazardous jobs. Bonus stamps were given for useful safety suggestions, or when all workers under the same supervisor were w/o injury or damage claims.	The trading stamp reward program (described in the evaluation plan column) constituted an extra-training condition that was in effect for 12 years at the uranium mine site and 11 years at the coal mine site. Add-on training factors during this time span consisted of the refresher training, plus biweekly "tool box" meetings to discuss "close calls" or hazards needing attention.	Post-treatment results indicated substantial reductions in injury rates, days lost, and cost factors. Relative to the pre-treatment level, the frequency rate of injuries dropped by 85% at the uranium mine; and by 68% at the coal mine. Days lost were reduced by 89% at the uranium mine and 98% at the coal mine. Savings based on ratios of costs for injury/damage claims versus reward payouts varied from 18.1 to 27.8 at the uranium mine and from 12.9 to 20.7 at the coal mine.	Study shows how training may have been a necessary, but not a sufficient condition for the improvements to have occurred. Authors note that keeping the treatment in effect for 11–12 years offers an extended opportunity to examine efficacy issues.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
12 foremen working in a paper mill that employed 200 hourly workers and 30 manager/support personnel. Foremen responsible for completing and filing accident reports according to plant policy. (Fox & Sulzer-Azaroff, 1987)	To effect more effort by foremen to supply all requested information on accident investigation report forms.	Limited to a one-page memo instructing foremen on how to complete reports and announcing they would receive written feedback as to the thoroughness in filling out the form and other reactions as to the merit of the entries.	Compare number of items completed on plant accident report forms for the following periods: 3 months pre-memo instruction (baseline 1); 7 weeks post-memo when foremen received feedback on submissions (intervention 1); 6 months after feedback withdrawn (baseline 2); memo reintroduced with feedback for 5 months (intervention 2); feedback again withdrawn—reports analyzed for 1 year (follow-up).	Offered/withdrew feedback at different times following instruction. See also Comments column on observer effect.	Intervention periods 1 and 2 where feedback delivered significantly improved the completeness of reports; when withdrawn after 7 weeks (baseline 2) and after 5 months (during follow-up) this effect declined.	Gradual decline in completeness of reports reinforced by company's acceptance of incomplete forms. Results indicate need for feedback to sustain effort. During the follow-up period, the researcher was absent from the plant, which also could have helped to cue the desired response. The authors indicate need for alternative forms of feedback or other contingent reinforcers to support the desired behavior.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
38 bakery workers in two departments reporting excessive numbers of injuries. (Komaki, Barwick, & Scott, 1978)	To enable workers to discriminate between safe/unsafe work practices and conditions, and to identify and promote the adoption of safer work routines.	1/2-hour session using slides to depict safe/unsafe ways of performing job tasks within the two departments. Baseline data on frequency of safe job actions posted and workers set safe performance goal.	Checklists used for itemizing/scoring safe behaviors by independent observers. Scores taken before and after the instruction periodically for 20 weeks in one department and 12 weeks in the second.	Weekly feedback on safe performance given to workers for 11 weeks in one department and 3 weeks in another, after which it was withdrawn. Supervisors asked to recognize/log times workers engaged in select safe acts.	Frequencies of safe acts in the two departments rose dramatically after 1 week of feedback (from 70% to 95.8% in one and 77.6% to 99.3% in the other) and remained as long as feedback given. When feedback withdrawn, rates fell to earlier levels. Feedback reintroduced by management stabilized safe performance level. Coincident was a drop in lost time injuries from 35 to below 10 per million hours of work.	That the maintenance of safe acts were so dependent on feedback indicates continued need to prompt such behaviors. Raises questions about workers internalizing the idea of working safely.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
55 workers in 4 sections of the vehicle maintenance division of a city public works department showing one of the highest injury rates as compared with other divisions. (Komaki, Heinzman, & Lawson, 1980)	To effect changes in worker behavior with regards to proper equipment/tool use, wearing personal protective/safety equipment, improving housekeeping procedures, and other actions aimed at upgrading general safety performance.	Accident logs for past 5 years reviewed and weaknesses in current safety program used to frame behavioral targets specific to each of the 4 sections. After baseline observations directed to existent behaviors, workers attended session to view/discuss slides of unsafe acts and ways to prevent them, which became formulated into safety rules. Copies of these rules issued to workers.	Checklist of prescribed safety behaviors was used by trained observers who monitored workers' actions in each section 3–5 times per week. Study plan had 5 phases where these observations were taken to show the effects of training alone, training plus feedback, withdrawing and then reinstituting feedback as compared with baseline data. Total study span was 45 weeks; phases varied from 5 to 11 weeks.	Upon completion of training phase, supervisors of each section indicated goals to be met in complying with safety rules and observed and provided feedback on level of adherence through graphic displays. In subsequent phases, this graphic feedback was withdrawn and then reinstituted to define its effect in enhancing safe behaviors as prescribed in the original training.	Comparing % safe acts against the pre-training baseline data for the various phases showed the following gains: Training alone = 9%; Training + feedback = 26%; Feedback withdrawn = 17% (reduced the previous gain by 9%); Reinstituting feedback = 21% (regained 4% of the previous loss). During the 8-month period of the program, lost-time injuries dropped to 0.4 per month; before program the rate was 3.0/month; after program the rate was 1.8/month.	Results show feedback as important motivator in realizing benefits of worker training and increased worker knowledge. Authors comment that management gave verbal support to program but was inconsistent in actions such as attending safety sessions or recognizing persons for their program efforts. Frequency of feedback notices by supervisors also dropped off in the last phase, which could account for less than the full recovery of the earlier gain.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
75 construction workers/managers who had completed coursework/seminars on occupational safety and health issues of consequence to construction work. (Lapping & Parsons, 1980)	To promote more and better effective safety and health protective measures in construction work, appreciate roles of labor, management, and OSHA in effecting such changes; improve reporting procedures; and identify need for further actions.	Workshops/seminars on construction health and safety were developed from and led by union craftmen/management graduates of two 3–4 week in-residence training programs with added fieldwork. Course content covered industrial hygiene, hazard analyses, communication/education techniques, cave-ins, fire protection, and OSHA laws re construction. 9 such programs conducted under the auspices of universities, building construcion trade council, operating engineers, etc. A total of 871 participants took the course.	Course recipients were polled by questionnaire as to the impact of the course. The report offers data from the first 75 respondees.	Added interviews with respondents to the questionnaire in three cities noted other activities that were prompted by the course or reinforced its value.	Of the first 75 respondents: 1) 77% noted that their OS&H activities had increased. 2) 93% noted increased OS&H measures on the job. 3) 96% indicated ability to furnish better protection. 4) 100% indicated increased competence. 5) 59% noted one component of course of marked value. 6) 92% noted better understanding of OSHA. 7) Up to 84% indicated that they personally had experienced an increase in work-related health and safety practices. 8) 99% appreciated need for management, labor, and OSHA to do more. 9) 36% noted novel management efforts to improve programs. 10) 18% were satisfied with enforcement.	Although positive, the data reflect subjective judgments and impressions; measures showing actual gains in construction safety/health outcome indicators remain to be seen.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
100 college students serving as subjects in a study comparing different instructional methods for effective, safe operation of a punch press simulator. (Leslie, Jr. & Adams, 1973)	To test hypotheses about the merits of audio-tape/slides vs. videotape vs. face-to-face oral vs. no instruction in performing safe, precision work on a punch press simulator.	Subjects divided into 4 groups, 3 given instructions via one of three modes (slide/audio-tapes, videotape, and oral reading of written job information by trainee and demonstration by running one cycle of the press) in understanding the elements of punch press operations. The 4th group, a control, viewed 2 job cycles but otherwise lacked any training. Training was done in one session in all cases.	Following training, subjects operated a punch press simulator with sensors to detect injury producing actions/events (signaled by a loud klaxon horn) and defective quality parts in feeding 100 blanks into the machine. Measures taken included the number of accident events, number of proper parts alignment, elapsed time until first accident, total time to process 100 blanks through the press.	Not applicable.	The oral/demo method yielded the fewest accidents followed by the videotape, slide/audio, and no training conditions. Measures of elapsed time to 1st accident, total time to process the blanks, and the number of misaligned parts showed no significant differences between the training methods. Performance curves showed decrease in accidents for all groups but also an upturn near the end ot the performance trials suggestive of a fatigue or boredom effect.	Authors explain superiority of the classical method over the slide/audio and videotape in that it allowed the trainees to have a hands-on experience with the equipment. Still, learning curves for the videotape and slide/audio groups indicated a faster rate of learning than for the oral/demo method. Practical recommendations from study were 1) value of simulator in screening persons who pose high risks for such tasks, and 2) indications of boredom/fatigue points for repetitive work requiring interventions.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
1800 full- and part-time employees of a large community hospital (Lin & Cohen, 1983)	To establish a system of hazard detection, reporting, and problem-solving involving the workers, and to assess the merit of their participation in terms of improved safety/health indicators and/or reduced injury-illness cases.	Employees first completed forms on their perceptions of unsafe work conditions, risky job tasks, and suggested ways for correcting them as a learning experience in hazard recognition and control.Worker subgroup appointed to safety committee ensured these data and later hazard reports filed by workers were logged, reviewed by hospital safety staff and control actions taken where warranted. Human-factors specialist gave the subgroup of workers special training to aid them in promoting hazard detection efforts of the total workforce.	For a 12-month period before and after the intervention, comparisons were made of the hazards reported by workers, the concomitant number of incident staff injuries/illnesses, and the relationship between the nature of the hazardous conditions reported and the type of injury or illness.	Monthly reports of hazards noted, and actions taken in response were posted as part of the employee-based hazard reporting system in all hospital departments. Select hazard reports and remedial measures also included in hospital newsletters to sustain interest. The worker subcommittee also had a special publicity campaign on work safety/health midway during the post-intervention period to bolster interest.	Preintervention worker hazard reporting rate was 11 to 32 reports per month, the average being 23.5 per month. After system startup, rate was 24 to 48 per month, the average being 36 per month. Increased reporting was spurred by the special publicity campaign halfway in the 12-month evaluation period. Preintervention, injuries/illnesses numbered 32–33 per month; post-intervention rate showed a decline to 24 per month. Pre and post period differences in hazard reports and numbers of mishaps were statistically significant. Content of hazard report vs. actual injury cases showed agreement in some cases and not in others. Detection of hazards as physical, fixed, and environmental in nature predominated; less obvious were those having behavioral and/or procedural features.	In actuality, the results indicated a need for worker training to better appreciate operational or functional factors as well as physical ones in hazard detection. The overall program was successful to the point that the hospital continued to maintain it after the researchers who instituted it completed their work.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
Underground mining operations that present hazards of unsupported roof falls. 113 miners, attending retraining classes, served as a field test group in assessing training packages intended to make them avoid such areas. (Mallett, Vaught & Peters, 1992)	To instill fear in miners of going under unsupported roof locations in underground mines so that they would avoid such areas.	Three sets of training materials, each composed of a videotape and an instructor's guide. In videotapes, miners described involvement in real roof-fall incidents, and answered questions on dangers, impacts on selves, and on others. Class in small groups discussed these points, and ways to minimize risk. Field test conducted on two of three videotapes.	At session's end, questionnaire items rated on interest in session, new lessons learned, intent to stay within “inby” supports. Second questionnaire given 6 weeks later as part of safety talk. Items rated on recall of earlier session, talks with others about it, thoughts, and actions to limit exposure to unsupported roof locations in mines.	None elaborated.	First questionnaire ratings: 98% of miners believed tapes realistic; 75% noted new learning; 92% to show more care to avoid unsupported roof areas. Later questionnaire ratings: 75% thought about getting hurt in a roof fall, 95% noted more avoidance of such areas; half indicated they or buddies had changed their work habits as a result of being sensitized to the dangers.	Results based totally on self reports, which is a weakness. Whether one fear-producing training session can effect a behavior change seems dubious, especially since roof falls remain relatively rare events. Will added precautions as expressed give way under pressures to maintain or increase mine output?

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
Commercial fishermen who fish in Alaskan waters. This industry has the highest occupational fatality rate in the United States. (Perkins R., 1995)	To train captains and crew of Alaskan commercial fishing vessels in emergency preparedness, survival procedures, vessel stability and loading, and methods for conducting safety drills. Overall goal was to reduce the number of drowning deaths due to vessel mishaps in the Alaskan fishing fleet.	20-hour course offered by Alaska Marine Safety Education Association (AMSEA) stressing how to abandon ship, fight fires, use distress signals, make distress calls, launch survival craft, don survival suits, and recover people from water. Practice in using safety and survival equipment included.	To determine for the 4-year period 1991–1994 the number of graduates from the AMSEA course who were listed as fatalities or survivors in boat incidents occurring during the same period.	Mention made that practicing the emergency drills described in the AMSEA manual were important factors in saving the lives of crew members in two vessels not included in the study.	AMSEA drill instructor course graduates for 4-year period were 1518. None of 114 deaths from 159 reported boat incidents for the same period were AMSEA graduates. Among 227 identified survivors were 10 AMSEA graduates. 8 of 86 vessels with survivors but no deaths had one AMSEA trained person on board; none on board vessels reporting at least 1 death.	Results suggest that course is reducing fatalities among Alaskan crewmen. However, the numbers of graduates are only 3% of the total number of Alaskan fishermen; this raises the question of whether those who took the course were more safety conscious than the average fisherman. In other words, whether this attribute, more than the course, was responsible for the outcome.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
Two groups of 100 workers drawn from two departments engaged in aircraft maintenance work at a large facility employing 20,000 workers. The departments had comparable hazards and safety records. (Ray, Purswell, & Schlegel, 1990)	To identify and promote compliance with appropriate safe behaviors in performing pressure checks, hand rework, welding, and machining tasks.	Both worker groups given safety training focussed on use of protective clothing, removing inappropriate personal clothes or jewelry, safe materials handling practices, and machine operations. Elements of these actions were identified and included in a form used to define a safety performance index for use by observers in monitoring worker compliance. Training plan included one group setting goals for the safety performance index and receiving feedback on their progress. The second group received no such feedback.	Training leaders observed workers in both departments using the safety index form to rate safety performance. These observations were taken at random times during a 2-week period to establish baseline data for each group. Safety performance feedback was then given to one group whereas the second continued without such feedback for a 5-week period.	The feedback given to one group for 5 weeks consisted of posting charts, providing weekly updates of their safety performance, and weekly meetings to discuss continuing violations and ways to correct them.	For the feedback group, the safety performance index showed a continuous rise from a baseline of 84% to 100% at the end of the 5-week feedback period. The untreated group's index varied little (from 88% to 90%) over the total 7-week period of observations. Differences between the safety performance indices of the feedback vs. non-feedback groups were statistically significant.	Authors noted added positive side effects of feedback program in that 1) the work areas became tidier and 2) both the workers as well as their supervisors showed an increased awareness of safety issues at the workplace. The simplicity of the feedback treatment induced senior management to consider its adoption for improving safety throughout the facility.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
105 workers in 11 departments of a farm-equipment manufacturing plant who accounted for 95% of the company's accident reports. (Reber & Wallin, 1984)	To create increased worker awareness of specific safe work practices and set goals to achieve compliance with such acts.	Over a period of 10 weeks, daily 45-minute training sessions held discussing manual of safety rules plus slides shown of safe/unsafe acts. In later sessions, items in observational checklist of select safe-worker behaviors were explained with goals set to achieve them.	Departments divided into 3 groups: training only, training+goal setting, and training+goal setting+feedback according to a staggered schedule. Midway during training workers given a quiz to determine their knowledge of safe work practices. Behavioral checklist used post training to determine effects of goal setting and feedback on occurrences of safe acts. Injury rates for one department computed before and after the intervention.	In one post-training phase, supervisors gave weekly reminders to the workers of the safety goals established during the training session. In a second phase, goal setting was augmented by feedback, i.e., posting the observed safe behavior checklist scores 2 to 3 times per week.	The effects of training, goal setting, and posting feedback were each found to increase the frequency of observed safe behaviors. Adding feedback to goal setting provided the greatest increase in safety performance. Injury rates dropped from a pre-intervention level of 84.7 to 55.1 per year post intervention.	Design allows for separate effects of training, goal setting, and knowledge of results to be appreciated.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
104 undergraduate college students serving as subjects in an evaluation of the effectiveness of accident simulators as a means of teaching safe operation of power tools. (Rubinsky & Smith, 1971)	To demonstrate the feasibility of simulating grinder tool accidents and their usefulness as a training device. Bench grinder modified to simulate a disintegrating wheel accident by directing stream of water at the operator's normal position in front of the grinder. Training objective was to teach operators when starting up grinder (when risk of wheel explosion is most apparent) to stand to the side so as escape injury.	Two studies run where Ss divided into 4 groups as follows: G-1 = written instructions and demonstration of correct start-up procedure; G-2 = same as G-1 plus demonstration of simulated accident; G-3 = same as G-1 plus subject experiencing simulated grinder accident; G-4 = same as G-1 plus demonstration plus subject experience with simulated accident. Task for all subjects was to run spark tests on 10 steel rods to determine makeup.	Number of simulated accidents occurring to subjects in running spark tests on the 10 rods used to measure performance during training session and during a retention session 1 week later. In 2nd study, each group had a second retention test 4 weeks after the original training trial where standard pedestal grinder was used.	Not applicable.	In both studies, G-1 Ss had most "accidents" and G-4 the fewest. All groups having either demonstrated or experienced "accidents" (G-2, G-3, G-4) showed safer operation of the grinder in both the training and retention sessions. In 4 week retention trial, only G-4 (demonstration + experienced with accident) had significantly fewer "accidents" than other groups.	Study indicates the potency of simulated accidents as a training technique, especially under conditions where the operator experiences the simulated "accident." A follow-up study (Smith and Rubinsky, 1972) varied the frequency and method of presenting the simulated accidents during the training trials. Retention measured 6 months post-training found those with the accident simulations had fewer accidents than those with traditional safety instruction.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
1136 shipyard workers organized into 13 departments. Small groups (4–13 workers/foremen) formed in each department were the focus of study in addressing housekeeping problems and how they could be controlled. (Saarela, 1990)	To identify and eliminate obstacles to good housekeeping, and establish new housekeeping practices in the various departments and for the personnel found therein.	Steering committee of top management plus safety staff provided information about program and main tasks with planning details, implementation left to department groups. Groups met to assess housekeeping problems in their own departments, developed remedies, held training seminars with all personnel to discuss goals for improved practices and set up a system to monitor results, which were posted.	Questionnaire surveys were used to gain reactions to the program's impact from group members and all department personnel at the end of 1 year. The program effect on accidents was determined on a before/after basis using yearly reports for cases of falls on the same or to a lower level, and of being struck by falling objects.	As noted in the overall program plan, all levels of the company organization had a function in the effort, which suggested a full commitment by top management on down.	More than half (53%) of the shipyard workers reported that housekeeping improved during the program. Departments varied greatly in this response: best was 92%; weakest was 28%. Changes in housekeeping most difficult for the largest departments (>100). Program year saw a 20% drop in relative number of accidents; this continued after the intervention.	Authors noted that groups used training, frequent measurement of the housekeeping level, and feedback to effect improved housekeeping practices in their department. Also stressed the participative feature in program success. Most active group in terms of meetings held and countermeasures taken reported the highest improvement score.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
300 workers per ship engaged in equipping two tankers; and 650 workers per ship in equipping two car/passenger ferries.(Saarela, Saari, & Alltonen 1989).	To promote better housekeeping practices with emphasis on keeping cables/hoses out of pathways, more orderly workplaces, and proper trash disposal.	For tanker work crews, informational campaign with 35 slogans conveying specific safety instructions posted at sites for the required action. Slogans displayed 3 times for 2-week intervals, the display time being 10% of the tanker-equipping period of 7 months. 17 slogans used for ferries, 4–5 posted for 3–4 weeks; total display time was 40% of ferry-equipping period of 9 months. Inspections/ratings of housekeeping made and posted on bulletin boards to tanker crews; posted and written feedback given ferry crews.	Worker crews equipping one tanker and one ferry were exposed to the slogan campaign and compared with those equipping a second tanker and ferry who were not. Interviews used to determine extent of worker recall of slogans, typically at the end of a slogan display period. Average number and severity (days lost) of injuries compared between the tanker and ferry crews having the slogans with those not.	Safety personnel in the shipyard received all interview reports on the slogan recall; not clear whether they made changes in subsequent postings in light of these data.	Interviews with tanker crews found recall for 3–4 slogans of 35 (or 11%); for the ferry crew, recall was 1–2 of 4–5 presented per posting (or 32%). Comparisons of injuries/week and severity rates for tanker and ferry crews found the slogans to have no significant effect. If anything, the crews having the slogans showed a slightly greater rate of injury frequency and severity. Feedback had a small positive shift on housekeeping level for the tanker crew; little for the ferry crew.	Results suggest the limitation in media campaign for effecting behavior change. The feedback effect also proved only marginal.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
32 workers in two production halls of a shipyard. (Saari & Nasanen, 1989)	To promote worker attention to and compliance with 9 housekeeping practices of consequence to both department safety and productivity based on foremens' suggestions, reviews of injury reports, and worker inputs.	1-hour training seminar given to workers, foremen, and production engineers focussed on the nine housekeeping targets. Pre-training (baseline data) observations on housekeeping problems shown and discussed.	Frequency of adherence to targeted housekeeping acts charted before, then at weekly, and then at 5- to 6-month intervals spanning a 3-year period. Injury reports before and after training reviewed to determine relation to any housekeeping improvement.	Feedback on compliance given to foremen for the first week post-training, then posted for all workers over a 6-month period. Compliance monitored for another 18 months in one hall and for 7 months in the second but with no feedback.	Compliance actions increased 29% in one hall; 22% in the second. Major changes occurred once feedback posted for all workers. Injury frequency fell by 75% during the 3-year post intervention period but improved housekeeping could only account for a 25% reduction.	Speculation that improved housekeeping leaves more capacity for noticing other potential hazards. Suggests that gains in housekeeping may facilitate other hazard control actions.
Five first-line supervisors of shipfitter crews showing excessive eye injury reports. (Smith, Anger, & Uslan, 1978)	To make supervisors more observant of worker use of protective eyewear and to reinforce increased use through praise and positive encouragement.	10 hours of instruction given supervisors in ways of observing, recording, and reinforcing worker use of protective eye glasses.	Before/after comparisons of dispensary reports of eye injuries for 5 crews whose supervisors received instruction versus others not subject to the intervention.	Supervisors of 5 crews responded with praise and encouragement to workers found to be wearing safety glasses in course of contacts at work stations.	4 of the 5 crews, after training of their supervisors showed a decrease in eye injury rate; the average decrease was 7.4 per 100 workers. This reduction made the rates of eye injuries comparable to those found for the other crews.	Data on actual use of safety glasses not reported. Later reassignment of supervisors posed problems in maintaining reinforcement of eyewear use.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-I. Safety/Injury Hazard Control

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
225 employees in three departments of a large (total workforce=3,300) telecommunications manufacturer engaged in producing, assembling, and wrapping circuit boards and electrical components where the highest inury rates were reported. (Sulzer-Azaroff, Loafman, Merante, & Hlavcek, 1990)	To promote worker adherence to safe work practices, targeting specificactions and conditions that could reduce the frequency and cost of work-related injuries.	Review of injury records, interviews with staff, direct observations of defined "hot-spots", and high-risk behaviors for effecting change. Workers "told how to perform safely" in these situations with specific behavior targets noted. Supervisory team used to oversee program with successively higher goals set to meet targeted objectives with weekly feedback to workers on their progress. Token rewards given at meeting interim goal; luncheon when 100% reached and sustained.	Weekly tours of the 3 departments were used to rate safety achievement; these were joint observations of safe worker behaviors and zones free of hazards. Scores were collected for an 11-week baseline period, followed by 24 weeks where increased goals were set and progress plotted. OSHA- recordable injuries were noted for the three departments 6 months before and 6 months during the intervention along with program cost vs injury cost savings figures.	Upper level managers from the Vice President down were working under incentive plans to improve company safety, and department managers had previous experience in using performance management training. This organizational environment was ideal for the behavioral approach used in the study.	Safety achievement scores for the 3 departments at end of study were 92%, 99%, and 100% as compared with baseline values of 70–75%. Relative to figures 6 months before, OSHA- recordable injuries 6 months post-intervention showed reductions in the 2 higher scoring departments, but the third increased. All departments showed a decrease in lost-time cases. The latter resulted in an estimated savings to the company of $55,000.	Authors conclude that effecting improvements in safe work practices was responsible for the reduced injury rate. Although this may be true, the lack of any analyses to show how the observed injury reduction was dependent on the targeted safe behaviors tempers this conclusion.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
16 groups of farm workers (total of 566 people) having pesticides expo- sures. (Barnett, Midtling, Velasco, Romero, O'Malley, Clements, Tobin, Wollitzer, & Barbaccia, 1984)	To inform workers on pesticide use, routes of exposure, symptoms of poisoning, simple first aid, and means for minimizing exposure, and governmental rules regarding protection.	Slide show, recorded narration featuring interview with poisoned worker, plus brochures were used to convey information. Question and answer session held with audience. Presentations and material offered in Spanish to match workers' background.	Audience split into three groups: One group interviewed with set questions before presentation to establish baseline knowledge, a second interviewed at end of session to determine immediate gain, and a third interviewed one week later. Spanish used throughout.	None specially noted but references made to the fact that the county from which the workers were drawn was the first in United States to require that warning signs be posted in fields of pesticide treated crops.	Increased knowledge on pesticide hazards noted for the two groups interviewed after the session; protective regulation questions were most difficult. 84.5% of audience believed pesticides a serious hazard to agriculture workers; information needs cited on persistence of residues in field and hazards posed by chemical drift.	Information obtained in this study resulted in revisions in audio-visual presentations to address problem needs as noted. Study addresses literacy factors and accommodation to language fluency of audience.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
8 lumbermen engaged in handling timber coated with chlorophenol, a preservative having known toxic properties, with dermal contact being the principle route for exposure. (Bentley & Horstman, 1986)	To counsel workers in the need to reduce contact/exposures to chlorophenol via use of gloves/aprons, application of barrier creams, washing hands at breaks, wearing clothes offering maximum coverage, and laundering them each day.	Training intervention conducted over a 3-week period. At start-up, 1) workers interviewed/answered questionnaire on personal protection and hygiene practices, 2) exposures to chlorophenol measured via air/urine samples, and 3) a fluorescent agent was added to the chlorophenol enabling the workers to see extent of skin contact using ultra-violet lamps. Workers counseled in need to follow personal protection, hygiene practices, and view areas of their body with UV light to show effect.	Air samples were monitored throughout the 3-week period to ensure no changes in work conditions. Questionnaire and urine samples were taken at the end of the 3-week session to compare with those taken at the onset to determine apparent shifts in use of protective measures and their effect on exposure and dose levels.	Workers were encouraged during breaks to visualize their contact with the chlorophenol by using the UV illumination.	Before/after tests of chlorophenol urine metabolites showed reductions for all but one worker, the median decrease was 32% for one metabolite (tretrachlorophenol)and 5% for a second (pentachlorophenol). Greatest reduction was for those who wore clean overalls each day. UV visualization detected previously unknown sources of contamination. Post training questionnaire responses showed shift to increased skin protective measures for 9 of 11 items.	Forms of feedback (use of UV light to illuminate dermal contact areas and needs for control) that dramatize the effects of behavior actions taken can be a potent motivator for such behaviors.

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
114 asbestos workers on the occasion of being recertified for undertaking such work. (Booker, Catlin, & Weiss, 1991)	Intent of 1 year refresher was to determine retention of original instruction and applicability of work practices to worksite situations encountered.	Original certification required 32 hours of instruction on legal issues, asbestos hazards, proper work practices, and use of personal protective equipment including respirators. 12 hours of this instruction was practical hands-on training.	Workers were retested on material from initial certification course by a questionnaire. Also asked how well course aided them in work area preparations, removal methods, glove bagging, decontamination, clean-up/take-down procedures, and how closely actual work conditions allowed prescribed procedures to be followed.	Not applicable	On retest, workers did better on specific work practices questions than those dealing with other issues. Most workers rated instruction better than adequate to fill job needs; some noted lack of time and contractor enforcement as complications to following prescribed measures. Trainees with most recent work experience gave higher ratings on prescribed work practices and health behaviors such as informing one's physcian of asbestos work.	Study not originally designed as an evaluation effort but gave opportunity for an assessment of original training. Results lack "bottom line" indication that the certification program is paying off in terms of reduced cases of asbestos-related disease.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
209 workers from 15 auto plants whose jobs involve use of solvents. (Bosco & Wagner,1988)	To compare knowledge gains and merits of interactive video training versus lecture/video-tape instruction on hazards in handling solvents and related safe-work practices.	Workers were divided into two groups who were instructed first with one method and then with the second in counter-balanced fashion. Training for both required one whole day	Workers were given before/after achievement tests, attitude/opinion surveys to measure knowledge increase, and interest/preference for instruction. Training time and demographic factors were also analyzed.	None.	Interactive video yielded fewer errors on knowledge quiz, more high achievers, and favorable interest in and use of information. Years of education showed correlation with knowledge scores. Test time for interactive video more variable than lecture/videotape as expected.	Results indicate positive response to more active, individual forms of learning. Evaluation conducted under psuedo-lab conditions that may limit conclusions. How much information is retained from either learning method remains open.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
118 workers representing 58 employers engaged in hazardous waste site operations. (Brown & Nguyen-Scott, 1992)	To promote employee actions aimed at defining and remedying major shortcomings in hazardous waste site control efforts.	Consortium of 6 universities and a state labor group formulated 5-day training program accenting worker participation, worker/instructor co-learning, and worker empowerment. Focus on 4 modules (of 20 total) on workers' rights and responsibilities, personal protective equipment, decontamination, and emergency response training. Risk chart from worker and instructor inputs used to define problems on these subjects. Via small group meetings, decisions made on problems to be addressed, remedial actions needed, and how to effect expected progress in 3 months. Contact persons selected for follow-up progress reports.	At 3 and 12 months post-training, trainees to undergo a standard telephone interview to determine 1) how successful in following up problems originally identified, 2) what obstacles met to implementing changes, and 3) did training help in correcting problems. Added questions probed for resource materials used and for discussions with management/co-workers on health/safety issues raised in courses.	See results section.	Results based on 3-month follow-up interview with 39 workers from 39 different employers. Three priority problems identified by trainees as a group were 1) inadequate supply of air purifying respirators and self-contained breathing equipment, 2) no adequate emergency plans, and 3) inaccessible information on hazardous chemicals at the worksite. 40% of trainees indicated that the most critical problems were corrected through their efforts (prompting management, sharing course materials with co-workers, holding health and safety meetings). 32% of trainees indicated some improvement; 28% indicated no improvement.	Article gives positive and negative features of training program. Among positive are the ways for focussing on prime targets for change and that the trainees interact and learn from one another and become the change agents in the process. Follow-up interviews serve as reinforcement tool. Some limitations were that the contact person tends to be a supervisor who might give a biased view of the worksite situation (since changed in that each group member is now a contact person); plan not feasible for those who have not yet begun to work or whose jobs require moves from one site to another. A concern about the evaluation itself was the self-report method, i.e., ex-trainees may respond in ways that the course evaluators want to hear.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
Conduct of a pilot OS&H training effort in a 100-worker foundry. (Caparaz, Rice, Graumlich, Radike, & Morawetz, 1990)	To enhance worker knowledge of hazardous materials found at their workplaces, recognition of symptoms, safe handling practices, and spill control measures and to generally improve their understanding of MSDSs, Also to appreciate noise, vibration, and physical hazards at work.	Training content based on interviews with 51 workers showing gaps in identifying chemical and physical agent hazards and means for reducing exposure risk. This produced a hazard communication manual for training that reviewed sections of the MSDSs and an add-on unit on physical hazards. 16 workers served as pilot group for training; small groups (3–4 workers) with similar exposure risks were used in one 2.5 hour session. Group discussion and exercises were used to foster active learning.	Worker knowledge of exposure agents in their workplaces was tested just before and at the end of the training session, and then at a 2-week follow-up. Also workers gave feedback on receptiveness to training approach.	None elaborated beyond that noted in the needs analysis which was the basis for the training content.	Post-test results at end of training session showed trainee knowledge scores to be higher and item difficulty scores to be lower. The 2-week follow-up tests showed some drop in these knowledge scores though they were still higher than the pre-test measures. Trainees stated that training was too short and too fast. No changes in content were noted.	Decreases in test scores at 2-week follow-up suggest need for more reinforcement of knowledge gain. Question remains as to whether knowledge gain will translate into preventive actions.

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
278 hazardous waste site workers, both English and Hispanic speaking, in blue collar, technical-professional, and managerial jobs. (Cole & Brown, 1996)	To promote more worker-initiated actions aimed at identifying and solving health and safety problems found at their individual waste sites.	Trainees enrolled in 3-day or 5-day worker-centered, training-for-action courses. At end of course, each trainee developed Action Plan to identify 1–3 health/safety problems at their worksite with specific steps they and employer could take at correction. 5 types of problems noted.	Approximately, 3–8 months after course, telephone interviews held with trainees to determine progress on Action Plan. Specific information sought on whether attempts made to address problems, were any corrected, and whether trainee participated in remedy.	Emphasizes how critical management support is to realizing gains from training. "Even the best training program will have only limited success if management is apathetic or resistant to changes in the worksite (pg. 741)". Recognizes training problems for non-English speakers that go beyond communication issues and workplaces that lack supportive structures for effecting worker-initiated actions.	Perceived management support enhanced attempted actions on problems (86% support vs. 67% nonsupport), and problems corrected (73% support vs. 56% nonsupport). Effect of management support on trainee participation was greatest for union and technical trainees (30% difference between support vs. non-support). Odds of Spanish speakers correcting problems were half those of English speakers.	Authors acknowledge limitations of self-reported results. Authors note that differences in the workers perceptions of what defines a problem, definitions of success, and over-reporting of success may be biased toward more positive findings.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
50 underground coal miners in one training evaluation; 283 persons engaged in coal mining work (e.g., miners, technical-maintenance, supervision) in a second. (Cole, Mallett, Haley, Berger, Lacefield, Wasielewski, Lineberry, & Wala, 1988)	To acquire skill in donning the self-contained self-rescuer emergency breathing apparatus (SCSR) to ensure its most rapid and flawless use in cases of mine fire, explosion, or gas inundation.	A first evaluation found the existing 14-step procedure for donning the equipment could not be performed proficiently for use in emergencies despite years of hands-on training and annual refresher demonstrations. Observations here yielded a revised "3+3" step plan built on 2 concepts to overcome position/sequence problems and slowed response. Modelling of new procedure and repeated opportunities for each person to observe peers were used for training with the new method.	Compare donning times for the new method vs. the old procedures, and sequential errors in performing critical tasks at completion of training session.	None elaborated.	Compared with the older procedure, the new "3+3" method reduced overall donning time by 50% and critical task time by 27%. Donning actions with the new method were also smoother than with the old, with fewer interruptions of subtasks.	Training evaluations were carried out in miner training rooms above ground that do not reflect the underground conditions of darkness, muddy/wet floors, and often dirty and battered SCSRs. Report notes that one company which trained its miners in the new procedure both above and below ground found more errors occured underground, slowing performance time. Authors suggest need to train to high mastery levels above ground to resolve these difficulties.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
19 workers drawn from 3 plants manufacturing fiberglass reinforced products (Univ. Kansas, 1982). (See also study below by Hopkins (1984) which is a follow-up effort).	To effect worker compliance with 11 work practices and 20 housekeeping actions aimed at reducing worker exposure to styrene, a hardening agent used in plastics processing, which is a known neurotoxin (and a suspect carcinogen).	Site visits and plant mapping indicated two operational areas (spraying and roll-out) where styrene concentrations were greatest and where targeted behavioral changes could have the most effect in reducing exposure. Training included viewing videotapes of recommended actions, on-the-job practice of the prescribed behaviors, and tests to show competency and feedback on results of such tests, and praise for good performance. Each plant had 9 training meetings spread over a 4- to 5-week period, each lasting no longer than 30 minutes.	Paid observers recorded worker compliance with instructed acts at random times before, during and after the training. Over the same periods, air samples of styrene concentrations were collected as were urine samples for mandelic acid assays to establish worker exposure dose. Data collection for 3 plants included baseline and pre/post training intervals using a staggered schedule. The overall period of data collection spanned 71 weeks.	From the beginning of training through the end of post-training, the trainer gave social approval whenever workers were observed to be following the procedures as instructed; or corrected them if they weren't. Monetary incentives were offered workers for cooperating in the effort and for passing tests certifying their competencies in the procedures at the end of training.	As averaged for the 3 plants, worker actions complying with the prescribed work practices increased from 74% at baseline, to 93% at the end of training, to 96% during post-training. Conformance with housekeeping behaviors increased from 34% at baseline, to 83% at end of training, to 92% during post-training. Pre/post air concentrations of styrene showed reductions ranging from 33% to 80% for the 3 plants; for bioassays, the reductions ranged from 26% to 55%.	The results support the conclusion that the training and motivational procedures altered the behaviors in ways that had the desired effect of reducing styrene exposure. The methods used were quite elaborate, which may make voluntary adoption by other employers doubtful. Use of a respirator was the least compliant behavior. See study below by Hopkins, 1984 which examines the durability of the changes observed in this evaluation.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
6 workers from 2 plants who took part in an earlier training program (Univ. Kansas, 1982) for controlling styrene exposures in fiberglass plastic manufacturing. (Hopkins, 1984)	To assess the durability of work practices and housekeeping procedures established through an earlier training/motivational program for reducing exposures to styrene, a toxic agent used in manufacturing reinforced plastic products.	Earlier training, 2 years before, effectively altered behaviors to conform with 11 work practices and 20 housekeeping measures. No new or added training given 6 workers who were part of the original training group.	Using same observers as in the earlier effort, frequency of acts conforming to the 11 work practices and 20 housekeeping procedures were recorded for the 6 workers and compared with their baseline and post-training data from the original study. In one of two plants, comparisons made for breathing zone measures of styrene to note any changes 2 years since the last measurements.	In the intervening 2 years, management had done little to maintain the behavioral changes resulting from the original training effort. One notable exception was more insistence on use of respirators for certain tasks because of the presence of a new supervisor. An add-on feature at the end of this 2-year follow-up was to reintroduce the feedback and incentives used originally for maintenance.	Of work practices and housekeeping measures showing 90% conformance in post-training for the 6 workers, 2/3rds still occurring at this level 2 years later. Practices that worsened from previously high compliance were those requiring frequent attention and extra efforts. Feedback and incentives at end of the follow-up trial strengthened adherence to some weakened practices. Reduced styrene levels were maintained.	Increased wear of respirators noted reflecting added demands by a supervisor but worker resistance still apparent.

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
89 workers from 14 hospitals whose jobs include sterilization tasks with ethylene oxide (EtO), a toxic agent regulated by an OSHA standard. (LaMontagne, Kelsey, Ryan, & Christiani, 1992)	1) To gain heightened awareness of hazards of EtO and needs for and ways for minimizing exposures; 2) identify barriers to appropriate controls and explore ways to overcome them; 3) cultivate worker participation in health/safety issues with the idea of having other positive effects.	Curriculum and training manual developed through a needs assessment based on EtO literature and current training programs, site visits to sterilizing facilities, interviews with workers, and consultations with OS&H experts. Plan included one 3- 4-hour session and a 1- 2-hour follow-up, 4–6 weeks later. Interactive techniques, small group discussions used throughout to reinforce learner-centered approach. Problem scenarios used to spark discussion and creative problem-solving. Demonstrations in sterilizing facilities to accent learning points.	Post-training questionnaires used to gauge utility of training, plus a comparison of its quality vs. 25 other types of OS&H programs funded by a State accident department in terms of the technical course content, instructional techniques, and transfer of training. Also, between first and second training session, trainees asked whether they had taken actions aimed at correcting or improving OS&H practices in their work situations.	None elaborated.	More than 84% of the trainees believed the course improved their hazard recognition and their ability to find solutions. 70% indicated that the training changed the way that they will do their jobs. The program was ranked 5th highest among the 26 assessed for merit. Positive changes were reported in the follow-up session at most sites, notably in expenditures for engineering control and personal protective equipment.	Evaluation measures are self-report and predominantly qualitative.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
35 foremen in a lead alkly production plant with significant blood/lead and urine/lead levels. (Maples, Jacoby, Johnson, Ter Haar, & Buckingham, 1982)	To promote awareness of lead (Pb) toxicity and value of specific work practices/personal hygiene measures (e.g., wash hands/face before eating, wear clean uniforms daily, proper use of respirators) to reduce exposure/intake of inorganic/organic Pb.	Group meetings held monthly of 8–9 foremen focussed on industrial hygiene of organic/inorganic Pb and its toxicity; and on the importance of specific work practices/personal hygiene, respirator fit testing plus training in effective use of such equipment to limit exposure.	Collect/analyze bimonthly blood samples and monthly urine samples before and during the course of training for a 1-year period. The blood/Pb and urine/Pb values were discussed with the groups of workers during the monthly meetings and compared with one another.	As foremen observed reduction in their own blood/Pb and urine/Pb levels, they shared information with people reporting to them.	Overall results showed a 40% drop in urine/Pb levels, a 24% drop in blood/Pb levels. Those having the higher urine/Pb (>100µq/L) and blood/Pb (>50µq/dL) levels showed the greatest reductions.	No observations were made to determine the extent of compliance with work practices. Authors believed that working with employees on small group basis allows for more tailoring of training to meet job situation. Study was a pilot effort; it was expanded to include all employees having high blood-urine Pb levels.

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
Workers engaged in hazardous waste site operations or as emergency responders to toxic chemical releases. (Luskin, J., Somers, C., Wooding, J., & C. Levenstein, 1992)	1) To meet the training requirements for hazardous waste site workers (40-hour course), industrial emergency responders (24-hour course) as contained in CFR 1910.120, and the 8-hour course for refresher purposes. 2) Adopt a learner-centered program stressing empowerment in meeting the above requirements.	Small groups engaged in problem-solving exercises wherein trainees work/apply information noted in lectures. Report-back sessions used to exchange ideas, discuss issues, and share personal experiences. Mock incident planning and role-playing in accident simulation used to promote learning and equipment familiarity.	1) Ratings of course value, quality of training materials, 2) pre-post knowledge tests, attitude questionnaire on health/safety items for emergency responders, and 3) follow-up survey of 1000 trainees on effects of training at their worksites, areas of major impact, and ways to improve course.	None elaborated.	Value ratings of 40- and 24-hour courses similar (81%–88% worthwhile; 90+% rated materials good or better). Results for 8-hour class lower (59% rated worthwhile; 80% good for materials). Pre/post knowledge gain = 35.5%. Attitude responses showed 15% to 40% shifts toward more preventive actions. Follow-on survey results: 50%–60% more willing to raise safety/health issues with employers; 60+% changed work habits; 47% believed improved safety programs had prevented accidents.	Weakness of evaluation is self-report nature of data. Also the response rate to the follow-on survey was only 14%, which raises questions about the representativeness of the results. Authors point out difficulties in a learner-centered approach. Tensions arise in trying to cover topic requirments in a given time, differing needs of the trainee group, and instructors having to learn new roles as facilitators.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
Union developed training program for workers at hazardous waste sites or who respond to emergency spills along with management level persons who have supervisory reponsibilities for such operations. (McQuiston, Coleman, Wallerstein, Marcus, Morawetz, & Ortlieb, 1994)	To enable trainees to become active participants in improving the safety and health conditions of their workplaces. Stress placed on providing trainees with tools, problem-solving skills, ways to access and use information resources in dealing with waste site hazard control concerns, and emergency response.	4–5 day learner-centered classes accented worker input, small group discussion, and problem solving exercises. Classes involved hands-on use of personal protective equipment, drum plugging/patching techniques, full dress spill simulation conducted. Trainees develop risk chart/action plan for follow-through improvements at their worksites.	Telephone survey 12 months after course of 481 union and 50 manager trainees from different sites. Data sought on 1) use of course materials, 2) secondary training of co-workers, 3) attempts/successes in changing program practices and equipment, 4) improvements in spill handling techniques at site, and 5) perceptions of overall course benefits.	To enhance follow-through actions based on course learning, it was recommended that each class include 3–4 members from a given site, one being a member of the site health and safety committee.	Over 70% of union and manager trainees noted use of course materials. Over 70% of union and manager trainees taught coworkers. Over 90% of union and manager trainees sought and attained changes in their site programs/equipment. Over half of trainees noted improved handling of spills since training; more than 80% felt better prepared to do so.	Report provides details on session content, instructional approach, categories of changes or improvements, and differentials in union/manager responses to the evaluative measures. On the latter, major difference is in improvements area where the union sees more needs for health effects training.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
4,802 public employees with job titles of motor vehicle mechanics, construction laborers, electricians, traffic maintenance, plant tenders, custodians, carpenters, plumbers, print shop workers. (Miichaels, Zoloth, Bernstein, Kass, & Schrier, 1992)	To increase employee's awareness/knowledge of chemical hazards at work, enable them to understand/use material safety data sheets (MSDSs), promote employee collaboration in solving workplace health/safety problems, and provide means for discussing issues and for sharing information across city agencies and shops.	To assess job-specific hazards and employee health/safety concerns in different jobs, plan developed by joint university, union, city OS&H office staff through site visits and interviews with workers. Amounts of chemicals in use noted. Training course, modified for specific job titles, covered the HAZCOM standard: toxic chemicals, routes of entry, symptoms and health effects, control measures, and how to read MSDSs. One 6-hour and one 4-hour session was attended by 15–30 workers with similar job titles, along with foremen and supervisors. Participatory exercises used throughout to allow workers maximal input in identifying hazards of greatest concern to them, and in working through solutions/obstacles to control.	Pre/post training questionnaires used to assess changes in worker knowledge of right-to-know regulations, worker rights/employer responsibilities, and MSDS-specific understandings. A right-to-know and industrial hygiene/control scales constructed from responses to these items.	See comments column.	Post training improvement on the right-to-know scale ranged from 17% to 37%; for the industrial-hygiene-control scale, the gain ranged from 4% to 27%. As the training stressed the need for follow-up actions by workers to correct workplace OS&H shortcomings, a number of these changes were also noted and attributed to the training exercise. These included changes in 1) worksite conditions (e.g., improved ventilation systems, added supplies of protective equipment), 2) policies (e.g., no acceptance of materials w/o MSDS, posting of radiation dose measures), and 3) better coordination among departments and offices doing OS&H work.	Authors emphasize that right-to-know training will raise worker expectations on workplace changes that improve safety and health. Failure of management to respond will create worker cynicism and hostility. Best training requires tailoring to the workplaces of concern. Packaged training programs believed less effective. Program quality suffered when individual trainers were perceived as being unfamiliar with worksites, and when workers perceived management as being unresponsive to job safety/health needs raised in program discussions.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
Workers in 14 coke oven plants subject to cancer risks from coke oven emissions. (Parkinson, Bromet, Dew, Dunn, Barkman, & Wright, 1989).	To increase worker understanding of the OSHA coke oven standard and knowledge of cancer risk from such work and to foster changes in work practices aimed at minimizing exposure to coke oven emissions.	Educational program consisted of 4 modules covering union/legislative events/actions resulting in the coke oven standard; types of cancer linked to coke oven work; information on work practices (use of respirators, personal hygiene behaviors) and other control measures for reducng exposure; and the status of such control actions at the plants under study. The education program was given 4× during a 2-year period at 7 coke oven plants.	Education program offered at 7 plants, using 7 others as a control. Baseline data from workers attending each education program were obtained via questionnnaire at the beginning of each educational program and by follow-up telephone interviews 1 month and 6 months later. Data collected on job health concerns, knowledge of requirements of coke oven standard, recognition of job cancer risks, and personal work practices that relate to them. Comparisons made among workers attending the program vs. non-participants vs. others in the control plants.	Union-directed program in concert with a university. Family members encouraged to attend programs. Refreshments were served and, in addition, small gifts were given to attendees (union emblems, pens, pocket flashlights).	Post-program interviews with participants indicated significant gains in knowledge of coke oven standard and adherence to safe work practices when compared with non-participants from the same plants and workers in the control plants. For those attending repeated offerings of the program, these results were even more evident, especially with regard to respirator use. Surprisingly, knowledge of the coke oven standard was low despite over 8 years of deliberation before final enactment. Non-participants felt too busy to attend.	Data on changes in work practices based on self reports, not direct observations.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
50 workers from 7 small factories where work processes involved significant use of and occupational exposure to lead (Pb). (Porru, Donato, Apostoli, Coniglio, Duca, & Alessio, 1993)	To increase worker knowledge of Pb toxicology/health risks and means for reducing exposure through proper work practices and improved personal hygiene. In addition, needs for reducing smoking and alcohol consumption which increase Pb absorption, stressed.	A 1-hour health education program undertaken in each of 7 factories where an occupational physician explained aspects of Pb absorption, health risks, and means for preventing Pb related disorders. The latter noted workplace safeguards (safe work practices/personal protective equipment use), personal hygiene as well as lifestyle factors of consequence to Pb toxicity (alcohol, tobacco intake). Booklets also issued workers to illustrate these topics.	Program was designed in 3 phases, which took place over 1 year. Phase 1 included worksite inspections to gauge plant hygiene, blood samples drawn to determine PbB levels in exposed workers, questionnaires given workers to assess their baseline knowledge of Pb poisoning and prevention. The 1-hour education session was part of this phase. Phases 2 and 3, carried out 4 and 12 months later, rechecked plant conditions, retested worker PbB levels, and repeated the questionnaire.	Authors note that during the 1-year period of the study no industrial hygiene improvements or engineering changes were made in the plants involved. Hence, any changes in PbB levels would have presumably reflected the effect of the education program.	Mean PbB levels for Phases 1, 2, and 3 showed a decreasing time trend, which was statistically significant. (The overall decrease was from 38.2 to 32.3 µg/dl). Questionnaire scores showed a similar significant time trend and overall gain of 25% for the same period. Added analyses indicated over 80% of workers showed reduction in PbB levels and 74% improved questionnaire scores.	Study did not include observations of any behavior change to ascertain the basis for the apparent drop in PbB levels. Workers reported changes in one or more behaviors, mainly increased use of protective devices and decreased use of alcohol and smoking. Authors infer that these changes could have been effected by specific knowledge gained in the Pb health education program.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
Workers in 5 manufacturing plants subject to requirments of the Hazard Communication rule. (Robins, Hugentobler, Kaminski, & Klitzman, 1990)	To furnish information to workers on hazardous materials to which they may be exposed, the hazards involved, methods for detecting exposure, and means for protection.	Plan implemented by joint management-labor committee that included train-the-trainer courses, preparation of 21 modules specific to industry, use of sessions with workers using videos, flip-charts for discussion. Plant practices varied in training time per employee (2.8 to 19 hours), group size (18 to 30), and time of session (before, beginning, during, end of workshift).	Worker reactions collected via questionnaire on usefulness of information, work practices, and use of control measures; also from interviews and feedback from union and management representatives to the joint committee. Data collected at three time points; at end of training, and at 1 year and 2 years post training. Company records of injuries and illnesses also reviewed over the 2-year time period.	Indirect post-training changes were improvements in plant health/safety control measures such as increased availability of personal protective equipment, quicker response to housekeeping problems, and substitution of safer chemicals for more hazardous ones.	Interview data found half of employees to rate program as helpful in handling hazard situations and near significant increases in safe work practices. Training delivery factors having most positive effects were 1) use of small groups, 2) brief training sessions, 3) held before or at start of shift, 4) allow more training hours. No difference found in number of injuries/illnesses after training.	Evaluation based on subjective reports. Only objective indicator was injuries/illnesses, which showed no change. This may be too soon to see any tangible benefits from the effects being reported.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
327 workers engaged in handling hazardous materials where they work and at treatment, storage, and disposal-type waste site facilities. (University of Michigan, 1991)	To foster safe work practices and other control measures in waste site operations such as to reduce the risk of exposure to toxic materials, and to other job health and safety hazards.	Training programs at four institutions covered information on worker rights and responsibilities, hazard awareness, identification and control, respiratory protection, personal protective equipment, instrumentation for monitoring, safe handling of toxic materials, and emergency response planning. Teaching methods varied among the 4 programs, some stressed small group discussions and/or exercises and lectures, and others stressed simulations, case studies and resource sharing. Also training time varied from 8 to 40 hours of instruction.	Mail-out questionnaires plus interviews were used to assess program results. Items dealt with helpfulness of training, perceptions of job hazardousness, changes in trainees' work practices, discussions about health concerns, and actions taken to address such concerns.	Not elaborated.	70% of trainees surveyed judged training to be helpful in hazard recognition, knowing where to get more information, or what to do about hazard situations they may face. More than 70% reported changes in their work practices since training, 90% had discussions with co-workers on what they learned in training, and 80% brought up health/safety issues with their supervisors. Over 50% desired added training on effects of toxic materials and legal rights.	Major limitations to this work are the self-reported nature of the results and the fact that the response rate was quite low (27%).

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
80 Canadian manufacturing plants, employing from 15 to 1200 workers, yielding a total population of 10,560. (Saari, Bedard, Dufort, Hryniewiecki & Theriault, 1994)	To make workers knowledgable of a Workplace Hazardous Materials Information System (WHMIS) that required 1) labelling of chemical containers, 2) use/availability of material safety data sheets, and 3) training workers to implement relevant procedures.	Five training options utilized in 80 plants, four offered by Canadian Safety Association (ASFETM), namely: #1 = ASFETM-trained trainers who trained workers (20 plants). #2 = ASFETM-trained employees directly (23 plants). #3 = Combination of 1 & 2 (12 plants). #4 = ASFETM-trained some plant workers (11 plants). The 5th option used a different, shorter form of training focussed on materials used at plant sites (14 plants).	Interviews with employer /employee representatives; knowledge tests to sample of workers having different contacts with chemical materials (painter, welder, storeroom clerk, machine operator); and worksite tour with checklist to observe quality of labelling, MSDS practices, use of personal protective equipment. A second visit to ascertain safety climate factors via observations and employee questionnaire.	Plants using the train-the-trainer option (1 & 3) had more organized OS&H activities and were better prepared for implementing the WHMIS than those opting for other approaches. Those using the direct training option (#2) exhibited little ongoing safety program activity.	Knowledge results best for plants trained with options 2 and 3. MSDSs practices better for plants using the #1 and #3 options; all plants scored low in labelling practices. The combined option (#3) was superior overall. Factors for success were number of safety programs, time spent on safety, effective use of PPE, and good housekeeping.	Direct training of workers in safety matters from outside sources may be best for companies whose safety activities are marginal; the train-the-trainer approaches may work in places where safety programs and related activities are better organized.

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
155 mine technical personnel whose tasks include regular mine visitations and 86 active underground miners. (Vaught, Brinch, & Kellner, 1988)	To acquire skill in donning self-contained, self-rescuer (SCSR) and the mode of instruction that best facilitates the process.	Training content used "3+3" donning method that blocked 2 basic action sequences, one for isolating the lungs, the second for preparing for escape. 4 modes of instruction used: 1) computer-based training + video demonstration, 2) lecture + video demonstration, 3) step-by-step live demonstration by instructor + video of real-time simulation, 4) video demonstration + hands-on trial with instructor.	Miner subjects divided/assigned to each of the 4 instruction modes. Following the prescribed session of instruction, trainee given a test donning trial. Proficiency measures included number and nature of performance errors, time to complete certain critical acts (e.g., isolate the lungs), and the entire donning procedure.	Not applicable.	Active trainee involvment hypothesized as being the best for instruction and the hands-on treatment. Mode 4 did show more perfect sequences than the other methods and the fastest time for critical tasks. Trainees made most errors in failure to activate oxygen, donning the goggles, and adjusting straps. The hands-on method had the fewest errors for these actions. Computer-based and lecture modes showed the poorest scores on the above measures.	Authors note that the evaluation indicated only a pre-practice measure of performance since each trainee would be expected to improve with repeated trials. As over-learning is believed key to proficiency in SCSR donning, time-resource constraints may complicate individual hands-on instruction as the method of choice for refresher classes. Suggestions for resolution include use of the other modes for refreshers or use of substitute SCSR devices for practice outside of usual refresher class time.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-II. Control of Health Hazards—Chemical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
Unspecified numbers of farm workers in New Jersey (and also Nicaragua) whose tasks subject them to pesticide exposures. (Weinger & Lyons, 1992)	To increase knowledge of health effects of pesticides, symptoms of poisoning, routes of entry, ways to minimize exposure, emergencies and first aid procedures, worker rights, and problem-solving for overcoming obstacles to gaining needed health/safety improvements.	Needs assessment took account of site visits to farms to document exposure hazards and work practices. Focal- and small-group discussions used to consider content issues, best modes for conducting training (adopted Spanish because of typical Hispanic makeup of audience), and attitudes as obstacles to learning. Training plan stressed a learner-centered approach for meeting information, attitude/emotion, behavioral skills, and problem-solving objectives of training. Techniques of role-playing, demonstrations, and case studies used to dramatize issues and promote worker participation.	Evaluations reported included biological monitoring measures of exposure (cholinesterase) and increase in level of worker activism to effect changes in response to apparent needs for safety/health improvements.	Authors emphasize that training activity alone cannot resolve problems of pesticide exposure. That the education program was part of an expanded effort using the media to increase public awareness, prompting formal sanitation surveys in the fields, and meeting with state/federal agencies to establish need for new regulations for legal action.	Workers having training were found to have higher cholinesterase levels indicative of lesser exposure to pesticides. Reflecting greater worker activism, there was greater worker willingness to testify about unsanitary working conditions, to file worker complaints for alleged violations, and to request agency inspections; these resulted in citations/fines in numerous cases.	Evaluation data are subject to other factors that can influence the outcomes noted. Extra-Training Factors column indicates the need to consider education as partly responsible.

A-III. Control of Health Hazards—Physical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
Telephone line staff from 6 districts in Australia whose outdoor work involves exposure to solar UV radiation, a risk factor for skin cancer. (Borland, Hill, Gibbs, Cappiello, 1990)	To reduce lineman exposure to sunlight especially during the 11 A.M.–3 P.M. summer hours through wearing hats and shirts, and application of maximum protection sunscreen to exposed skin.	An educational campaign "Cover yourself against skin cancer" was used to promote worker actions for maximizing protection against solar/UV hazards. Planned weekly poster displays plus a video segment of a young man dying of melanoma to alert people to avoid excessive sun exposures were distributed at depot stations with folders for each worker containing information on the campaign. Buttons urging protective measures and anticancer brochures were also included. Nurse staff also added inputs on sun protective needs.	Three telephone districts, the intervention groups, were subject to the campaign activities; three others (controls) were given only normal occupational health-safety care. A checklist was used by senior staff to observe sun protective actions taken by linemen during 11 A.M.–3 P.M. duty hours. The checklist rated type of hat/shirt coverings and extent of shade available/used to derive an overall protection score. These data were collected for intervention and control groups 2 weeks before the campaign (late Nov) and during the last 3 weeks in late Feb/early March.	The report notes that the telephone linemen campaign took place in the context of a large community based "SunSmart" effort by an anticancer council. The authors suggest that the worker effort, being more focussed, may have provided added impetus for effecting the prescribed behavior changes.	Pre- vs. post-campaign comparisons for the intervention groups showed little difference in wearing of hats (less than a 2% difference in type/frequency of head covering); a greater difference in wearing shirts (especially short-sleeved, which rose 65% at the expense of no upper body attire), and tendencies to work more in partial shade. Combining all measures into a single protection index, the intervention group had an overall 6% higher protection factor than the control group.	Statistical analyses found weather conditions (temperature, cloud cover) during pre/post observations to have no effects on the reported results. Checks on biases in observation, and repeated observations on the same linemen proved unfounded or adjusted for in the reported analyses. Effort shows the merit of a marketing approach especially in reaching large numbers of a target audience.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-III. Control of Health Hazards—Physical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
7368 medical personnel (physicians, dentists, and technicians) and 1084 nonmedical (power plant) workers from different regions of Taiwan requiring licensing for use of equipment having sources of or generating ionizing radiation. (Cheng, Yang, and Wu, 1982)	To ensure knowledge of safe use of ionizing radiation sources and equipment used in hospitals, clinics, laboratories, and industry and of means for radiation monitoring and protection. Evidence of passing final examinations in the training courses was needed for issuing an operating license.	1-week training courses were given, the contents differing for medical and nonmedical personnel and professional or technician level persons. Material was presented via lectures, movies, and on-site demonstrations. Instructors were senior faculty members of universities, research institutions, government agencies. Class size was limited to 40 persons.	Effectiveness judged by number of persons passing the final course examinations for a 6-year period of offerings for the medical personnel and a 4-year period for the nonmedical group; also by tracking the nationwide trend in per capita exposure dose obtained from the film badges worn by medical and nonmedical personnel for the time period 1960 to 1979.	Inspection for licensing different sources/types of radiation equipment found in medical facilities, industry, and nonmedical establishments was also undertaken during the time of the training as part of regulations issued by the Atomic Energy Council of Taiwan.	Overall percentage of medical personnel passing the test was 87.9%. The passing rate for nonmedical persons was 80.5%. Radiation dose beginning in 1970 and continuing through 1979 showed a decreasing trend coinciding with the introduction of the training and licensing actions noted. The per capita drop in dose from 1970 to 1979 averaged 80% across the different personnel groups.	These results offer a nationwide picture of an intervention effort where standards imposing controls thru licensing of sources and users of radiation equipment plus training requirements played a role in reducing exposure levels. The exact contribution of the training or its quality in producing this result cannot be determined.

A-III. Control of Health Hazards—Physical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
94 active full-time city firefighters showing evidence of high frequency hearing loss suggesting needs for hearing conservation measures. (Ewigman, Kivlahan, Hosokawa, & Horman, 1990)	To increase firefighter knowledge of noise hazards to hearing and how it can be prevented through use of ear protective devices. The need for this training was based on 1) a survey of sources/levels of firefighter noise exposure (e.g., engines, horns/sirens, pumps) which found 78% of the measurements to range between 89 and 110 dbA, and 2) 20% of firefighter audiograms showing threshold losses of 40 to 60 dB in hearing 3000-, 4000-, and 6000-Hz test frequencies in one or both ears and 14% with still greater losses.	The intervention effort included 1) a 1-month education program using hand-outs, videotapes, lectures, and interviews with afflicted firefighters on noise hazards, hearing loss disability, and aspects of prevention, 2) issuance of 3 types of ear protective devices (roll-up foam plugs, premolded plugs, and ear muffs) for use during emergency runs for a 2-month trial.	Questionnaires mailed at the start and end of the 1-month education program to assess knowledge of noise hazards and hearing loss risks, attitudes toward wearing ear protective devices and indications of use in emergency runs. At the end of the 2-month trial period with ear protectors, interviews held to learn of problems and actual use over that time.	Fire department administrators supportive of the intervention, but they did not direct any firefighter to use ear protectors nor did they issue a policy on use of such protection during the trial use period.	Post-education questionnaire results found significant knowledge gains (average 14%; key items showed more than 25% increase), and positive attitude shift toward use of ear protectors (15%–20% shift noted for key items). At end of 2-month trial, 85% noted use of ear protectors as compared with only 20% use before.	Authors note that after the study the fire department provided ear protectors to all personnel and issued a policy requiring their use on runs. 6 months after intervention, shift commanders reported most firefighters regularly using ear devices. Practical limits on use also recognized, e.g., interferes with communications at fire scene, time to shape foam plugs poses problems as does wearing certain muffs under fire helmets.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-III. Control of Health Hazards—Physical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
Ten 8-person teams of nuclear power plant control room operators and adjunct staff having needs to respond to unforeseen, dangerous events. (Janssens, Grotenhuis, Miichiels, & Verhaegen, 1989)	To effect teamwork capabilities in detecting and correctly evaluating unusual, potentially dangerous events through strategies emphasizing the continuous and spontaneous exchanges of information among the team members.	3-day training began with discussions of case incidents in other plants, a fictional situation in their own plant and inspections of their plant to detect deviations for transmittal to others for action. Intent was to promote teamwork and exchange of ideas. A simulated plant disturbance was programmed, and the team went about a problem-solving exercise. Different teammembers paired off to learn one another's job, thus opening added means for communication.	Team members noted the extent to which the training improved communications and information exchange in handling unusual events by ratings on a 10-item scale. Scale covered skill in solving problems as a team, transfer of messages between shifts, feedback on disturbances, quality of information exchange with superiors, etc. Only posttraining evaluations conducted some years after the instruction.	None elaborated.	10 teams indicated significant improvements in different communication activities (e.g., problemsolving as a team, information exchange with superiors and others in maintenance, and from one shift group to another). No significant improvement noted for skills in operating components that cannot be routinely serviced, adequacy of control room layout, and skills in actually managing disturbances.	Evaluation lacks a more objective scheme for rating the effectiveness of the training, especially in coping with untoward events. Results are encouraging in showing improved communications, but skills in actually managing a crisis situation seem to be unaffected.

A-III. Control of Health Hazards—Physical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
1716 workers in a complex of 8 plants, each with similar noise levels (averaging 90 dBA), plant processes, workforce size, and percentage of ear protector use. (Karmy & Martin, 1980)	To determine the effects of education in hearing conservation (through posters plus use of a videotape depicting the need to wear ear protection in excessive noise), repeat audiometry, and education + audiometry on ear protector use.	Workers in 8 plants comprised 4 treatment groups: 1) education, 2) repeat audiometry, 3) education + repeat audiometry, and 4) control. Education was a poster campaign with 6 poster designs advocating use of hearing protection started midway in a 22-month study period, followed by a videotape showing on hearing conservation at 13 months. Audiometry started at 3 months and repeated 7 to 12 months later on same workers.	Main measure was to compare the increase in percentage of workers observed to be wearing ear protectors before and after the various treatment conditions.	Results of repeat audiograms not given workers.	Ear protector use in 2 plants serving as controls remained at 5% across the whole 22-month period of data collection. In comparison, use of just posters starting at 11 months caused a 15% increase in ear protection, which then declined; adding the videotape at the 13 month point caused an upsurge in use rate by 25%. Audiometry by itself increased ear protection by 40% in one plant and 20% in a second. Repeat audiometry + education attained a maximum 30% increase in protector use.	The authors suspect that differences in time between successive audiograms was responsible for one plant showing a greater ear protection effect than did the other. Also, giving workers knowledge of their audiograms would have increased its effect. Still audiometric testing proved to have the greatest effect, which seemed more sustained than the educational approach. The effect of the latter treatment appeared less durable.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-III. Control of Health Hazards—Physical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
Labor force size of 120 doing heavy industrial maintenance work in a gas diffusion plant with exposures to high wet bulb globe temperatures, i.e., 34.4˚C WBGT in summer; 26.6˚C WBGT at other times. (Millican, Baker & Cook, 1981)	To educate and train workers to recognize heat stress hazards and adopt measures to reduce risk of heat stress incidents. Also to train supervisors in maintaining close surveillance of workers in hot areas and in exercising control actions (e.g., mandatory rest breaks) as warranted.	Through safety films, booklets, medical alerts, safety meetings, and plant industrial hygiene bulletins, employees taught to recognize first signs of heat exhaustion and made aware of preventive measures. Emphasis on self-pacing of work tasks, taking breaks as needed in special cool rooms, increasing water intake, and avoiding heavy high fat meals before hot work duties.	Analyzed record data of exposure time, the number of heat stress incidents, type of work performed, and size of workforce over a 6-year period which were the peak years for the heat stress control program at the plant site.	Besides education and training efforts, transportable cool rooms were located near work areas for workers to take breaks of more than 3–5 minutes and air conditioners were installed in crane cabs to control temperature. Large refrigeration units also were used from time to time to pump cool air into work enclosures. Dry ice cooling vests were made available to workers but were not used.	Record data for moderate level work during the hotter summer months (WBGT 30˚C–38˚C) for the 6-year period 1974–1980 yielded 3 heat stress incidents for 700,000 hours of work. The nonsummer months, (WGBT 23˚C–30˚C) for the same 6-year period found no heat stress cases for 1.7 million hours of work. Time studies showed workers adopted a 50-50 to 75-25 work regimen in pacing themselves per instruction.	Authors note one heat stress incident due to air conditioner failure in a crane cab and was thus not a training associated problem. Authors emphasize success of program in limiting heat stress cases was the result of administrative controls (training, self-pacing, supervisor surveillance) plus the physical control measures put in place (cooling rooms). Study lacked reference data to gauge true program effectiveness.

A-III. Control of Health Hazards—Physical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
Unspecified number of enlisted personnel engaged in aviation maintenance work where noise levels dictated needs for hearing protection. (Sadler & Montgomery, 1982)	To motivate greater use of ear plugs or donning earmuffs in high noise areas among exposed personnel.	Treatment group subjected to psychological techque of positive practice overcorrection (i.e., if caught w/o ear protectors, would stop and practice inserting ear plugs or donning ear muffs 5 times) to increase ear protector use. The treatment was applied by non-commissioned officers in either a leader directed (LD) or leader participative (LP) manner. A second group (control) had daily safety briefings to reinforce need for hearing protection.	NCO leaders made unannounced visits and unobtrusive observations of the frequency of ear protector usage among their personnel during a 1-week period before the technique was applied, for 2 weeks during the application process, and two weeks after the treatment ended. During the latter post-treatment period, participants rated the merits of the technique for increasing ear protector use.	Discussions held with NCO leaders to elaborate on the techniques to be used and their roles as observers. Enlisted men in orientation period told of procedures and entered into a verbal contract to adhere to the overcorrection technique. Each of these orientations took an hour.	Compared with pre-treatment measures, the LP group showed a 33% increase in ear protector use during the applications phase; the LD group a 19% increase. The control group change was 3%. For the post-treatment phase, the LP group dropped 15% in use level; the LD group lost 13%. The control group had a gain of 8% in the post-treatment level. The LP group rated the technique as most helpful and better than others for increasing ear protector use.	Although authors stress gains from use of either LD or LP overcorrective application, the losses in the post-treatment phase suggest the technique does not have lasting effect. Since the participants were told before the post-treatment period that they were no longer required to continue the technique, this could have been interpreted as permission to forgo wearing protectors.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-III. Control of Health Hazards—Physical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
3 groups of workers, varying in size from 28 to 58, drawn from 3 worksites having noise levels between 85–92 dBA. (Yarrall, 1986)	To increase knowledge of noise hazards to hearing, and need for hearing conservation through use of hearing protectors.	3 group education sessions held at 1 site with audio-visual aids to elaborate on what noise is, hearing function, noise effects on hearing, use/types of hearing protectors. At 2nd site, each worker's hearing tested; the results were given by a nurse who counselled the person on hearing conservation in noise. Workers at the 3rd site served as control group with no instruction. Interventions spread over a period of 6 months to cover the workers/sites.	A pre/post questionnaire was used to determine the knowledge and attitude of the workers toward noise and the wearing of ear protectors, and a behavior survey was conducted at the 3 worksites to observe the number wearing ear protectors before and just after the intervention and for up to 9 months later.	Other than the monitoring to note actual use of ear protectors after the intervention, no other factor was noted.	Pre/post questionnaire data for the 2 intervention groups showed increased awareness of noise problems, knowledge of noise damage to hearing, and use of hearing protectors at work. The group with hearing tests + counselling showed the greatest shifts (17%–20%) for these measures as well as greater numbers observed to be wearing protectors during worksite inspections. However, the greatest level of actual ear protector use was only 40%.	Authors believe that interventions were strung out over too long a period without adequate reminder/reinforcing material (posters, print material), which diluted the effect. Authors recognized, too, the need for more management support to create greater impact.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-III. Control of Health Hazards—Physical Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
80–82 workers in each of two departments of metal fabrication plant exposed to noise levels 87–99 dBA. (Zohar, Cohen & Azar, 1980)	To promote greater awareness of noise hazard to hearing among workers at risk and increased motivation to wear protection.	Standard lecture on hearing conservation given workers in both departments. Add-on hearing tests given to those in one department along with interpretations of temporary threshold shifts (TTS) when wearing and not wearing ear protection during work shifts.	Observe earplug use during weekly tours of both departments for 1 month before and during 5 months after the training treatment phase.	Audiograms of workers who wore ear protectors and those who didn't posted in production halls to further stress benefit of use. Management's earlier efforts to promote use through posters and lectures were ineffective; disciplinary actions also failed.	Treatment groups receiving TTS feedback showed ear protector use to increase from 30–50% at baseline to 85–90% at end of the 5-month follow-on period. Lecture-only group use seldom exceeded 10% for the same period.	Widespread use of ear plugs with strong support by management established norms in department for maintaining the durability of such practices.New entry workers wore plugs without need for TTS feedback treatment.
180 weavers in one textile plant (A) exposed to 106 dBA noise levels; 70 weavers in a second textile mill with 109 dBA levels. (Zohar & Fussfield, 1981)	To promote greater awareness of noise hazards to hearing and to motivate greater use of ear protectors in noise.	Typical lecture on hearing conservation with emphasis on wearing ear protectors at the workplace.	Compare earplug use for 2 months before with that following the issuance of token rewards for periods ranging from 3 to 5 months.	Add-on feature in Plant A was for supervisors to issue token to workers wearing earplugs, which were redeemable for gifts. In Plant B, the token value depended on how many in the group were using the plugs. The tokens were given during a 2-month period and then discontinued.	For Plant A, earplug use increased from 35% to 90% just 1 week after token issuance began and remained unchanged for 5 months after the tokens stopped. Similar findings with Plant B.	Management involvement in this intervention and the token issuance aided in the behavioral change. Such widespread use established norms for ear protector use; this prompted new entry workers to follow same practices even without the token rewards.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-IV. Control of Ergonomic Hazards

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
6 health-care staff serving persons with multiple physical handicaps/ambulatory problems in an infirmary unit showing excessive numbers of injuries while transferring clients. (Alavosius & Sulzer-Azaroff, 1985; 1986)	To learn and apply sequence of steps (e.g., prepare patient or surface for transfer, maintain proper body position/posture, lift/place and secure patient on new surface) in reducing stress of patient transfer tasks. Steps based on the manual lifting literature and consulting with physical therapists.	Each caregiver given written instructions in performing steps and verbal feedback from on-the-job checks by trained observers using checklists for rating safe/unsafe components of patient transfers. Observers trained to ensure accuracy in use. Observer checklist data used in weekly verbal feedback to caregivers in efforts to have them learn/comply with proper lifts. Feed-back subsequently withdrawn to assess retention 1 week to 7 months afterwards.	Observer checklist data defined components of safe transfer actions for baseline, feedback, and post feedback periods of data collection. In addition, the caregivers were given a questionnaire asking their opinion of the procedures used in the intervention.	Other than the feedback given individually to the caregivers as to their compliance with safe transfer actions as part of this on-the-job evaluation, no other factors mentioned.	The feedback period was marked by improvement in safe performance for those 10 components that scored lowest during baseline (occurred in less than 75% of the observations) with others remaining at a high level. After feedback, 4 of these components fell back below the 75% observed level. Responses to the questionnaire were positive; all agreed that the feedback improved the safety of their transfers.	Feedback in this application was individual and private as opposed to other studies where it was a group effort, posted for public viewing. Authors suggest that this argues for the generality of the procedure. No effort was made to note any changes in the injury rate. In view of the small sample size, no changes in this measure were expected.

A-IV. Control of Ergonomic Hazards

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
30 food service workers whose tasks included frequent, fast-paced lifting, lowering, and transfer of trays, other objects of varying weight. (Carlton, 1987)	To teach workers the straight back/bent knee method of lifting and recognition of 4 high-risk workstyle factors (i.e., horizontal displacement, spinal torque, pace/object control, forward/rearward stability).	Workers divided into 2 groups, one (experimental) receiving a 1-hour body mechanics course emphasizing the high-risk work-style factors and the necessity of straight-back, knee bent position in lifting. Videotapes of the workers style of lifting/lowering a 20-lb box assessed by instructor, and kinesiologic models used to demonstrate least stressful techniques. The 2nd group (control) received no such instruction.	The assessment included 1) scoring worker's body mechanics as applied to a novel task of lifting/lowering trays weighing 5 to 30 lb performed 2 weeks after the 1-hour course, and 2) similar scoring for lifting, lowering, and transfer acts as observed in their actual work enviroment 1 week after the above evaluation. The scoring used a 17 point checklist that noted control of the various risk factors and use of straight-back and bent-knee posture.	The workers were told that the researcher's presence in the work environment was to do a job analyses when in fact he was scoring their body mechanics in lifting, lowering, and transfer. [See Comments column for mention of factors in work environment believed of consequence to one set of findings.]	The worker group receiving the body mechanics instruction scored higher on the novel lifting and lowering tasks than did the control group in demonsttrating better risk control actions. On the other hand, no differences were observed between the two groups in scores obtained for their on-the-job behaviors. Thus, although the workers showed knowledge gain from the instruction in a novel test, it was not transferred to the worksite.	Factors the author notes as thwarting transfer included the layout-obstacles in the workplace that made the workers assume awkward positions in handling loads; the pace of work that precluded optimal time for follow-through of acts prescribed for risk reduction. Needs noted for analyzing the work area to establish most practical techniques, effective training time, and practice to overcome habit patterns that are inherently stressful.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-IV. Control of Ergonomic Hazards

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
26-33 warehouse workers engaged in lifting/moving boxes from shelves to pallets. (Chaffin, Gallay, Wooley, & Kuciemba, 1986)	To learn 5 specific lifting principles (i.e., keep load close, torso erect, lift smoothly, good grip, don't lift/twist) for minimizing stress in lifting tasks.	1-day supervisor sessions + a 4-hour session with workers using the VISUCOM low-back prevention program to emphasize the 5 practices for minimizing lifting stress.	Lifting posture of workers video-taped before and 35–51 days after training to determine compliance with the safe lifting practices.	Supervisors were supportive of training but instructed not to react to lifting postures during intervention.	Training improved 2 of 5 lifting practices (jerking of loads, and inadequate grips).	Some practices harder to adopt because work station layout factors and package size posed constraints. Question of whether modified behaviors could be maintained or others effected by added reinforcement and instruction.
18 workers who performed hand insertion tasks in electronic assembly work posing a risk of chronic trauma disorders (CTDs). (Dortch III & Trombly, 1990)	To learn 6 principles of joint protection (e.g., avoid joint stresses in positions of deformity and prolonged holding of joints in one position as used by persons with rheumatoid arthritis) to reduce stresses in current jobs.	Workers divided in 3 groups (G-I, G-II and G-III). G-I and II given 30- to 45-minute information session on CTD risk factors plus handouts showing less stressful hand/wrist positions in manual work. G-I left to read/practice concepts on their own. G-II had added 1-hour session for discussing these ideas and practice the positions on a simulated job task. G-III received no such information.	Checklist of 8 diagrammed stress-producing hand/wrist positions was used to sample worker hand use patterns at the end of each 15-second interval of a 15-minute work period. These observations were made before and 1 week after the training session ended.	None noted.	G-I and G-II showed significant pre/post training reductions in frequency of at-risk positions (29% and 34%, respectively). G-III (control) showed no change. Although showing the benefits of training, G-I/G-II differences were insignificant, indicating that the added discussion time and practice did not improve performance.	That workers showed benefits from the brief training sessions is remarkable. Nevertheless, limits on the amount of training time and a 1-time 15-minute evaluation period do not offer convincing evidence for durable changes.

A-IV. Control of Ergonomic Hazards

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
94 nurses, aides, and orderlies in 2 medical/surgical units at 2 medical centers engaged in patient transfer tasks posing lifting-back injury risk. (Feldstein, Vollmer, & Valanis, 1990; Feldstein, Valanis, Vollmer, Stevens, & Overton, 1993)	To effect use of patient transfer practices that offer options for reducing the incidence of excessive lifting tasks and flexibility exercises as a further safeguard against mild back discomfort from manual handling efforts.	Didactic and practical on-the-job instruction used to explain/demonstrate 1) specific transfer techniques, 2) proper body mechanics for lifts, 3) one-on-one assistance, 4) use of equipment aids, 5) environmental problem-solving, and 6) muscle stretching and strengthening routines. Didactic sessions were 2 hours with handouts for reference. Each session followed by 8 hours on-the-job instruction where trainees given feedback on their transfer techniques.	55 workers in one center served as intervention group; 25 others in 2nd center were controls. Personal histories taken on both groups for baseline data on job service/back injury problems. Monthly back pain/fatigue questionnaire data were collected and ratings made of appropriateness of transfer actions before and after the training intervention. Muscle flexibility and proprioception measures also obtained as possible moderators of the results.	Intervention program took account of several suggestions for maximizing participation, namely, paid worker time for involvement, double staffing during didactic sessions to avoid work accumulation, and program plans that limited interference with usual workflow.	Based on observer ratings, post-training improvement in preparation of transfer, position for transfer, and actual transfer ranged from 15% to 25%, which was statistically significant. The control group showed no such change. The intervention group scores on back pain and fatigue dropped after training but not significantly. The control group showed no change. Those reporting back pain showed less flexibility; proprioception scores were indifferent.	Results based on only a 1-month follow-up that the authors admit is too soon to draw conclusions. Suggest a larger sample size plus a longer follow-up period for evaluation. Even with the paid work time and extra nurse coverage, participation in study was only 59%.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-IV. Control of Ergonomic Hazards

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
70 hospital nurse respondents drawn from a population of 750 who completed a manual handling training program. (Foster, 1996)	To promote changes in nursing practices aimed at reducing the risk of musculoskeletal injury from manual handling of patients.	Training program followed Scandinavian Back School principles. Elements were: Principles of correct lifting, body mechanics, fitness, ergonomic design, unacceptable lifting techniques, demonstration, and practice of acceptable manual handling techniques with and without the use of mechanical assist equipment.	Mail questionnaire survey approximately 1 year after course. Items asked on whether work practices had changed, increased awareness of duties regarding 1992 UK regulations on manual handling operations, and use of patient lifting techniques as prescribed with and without mechanized devices.	Authors suggested that limited use of techniques may be because their nursing tasks (primarilly out-patient) did not warrant them. At the same time, more than half of the respondents believed that limited time and staff precluded their compliance. In view of the few occasions that they do arise, is the press of time that significant?	Between 73% and 77% of respondents indicated post-course changes in work practices, improved use of equipment, and greater awareness of legal duties regarding issues of manual handling. Other items on handling techniques revealed, however, that no more than 50% had actually used any of the instructed procedures. Those that did, used them fewer than 5 times the previous week.	Mixed results require explanation as to factors that might be undermining the impact of the instruction. Aside from author's thoughts (see Extra-Training Factors column), conditions needed for positive transfer may not be present. For example, are supervisors supportive and insistent on safe lifting procedures being used?

A-IV. Control of Ergonomic Hazards

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
50 nurses aides and 10 nurses in a geriatric hospital. Focus of study was on low back problems, primarilly in aide group, and its reputed linkage with patient lifting, patient movement tasks. (Gundewall, Liljeqvist, & Hansson, 1993)	To increase back muscle strength and endurance through an exercise program for purposes of preventing back pain complaints or actual working days lost as a result of work-related back problems.	20 minute workout programs for a group of 28 aides/nurses were developed during work hours. They included special exercises for increasing the dynamic endurance, isometric strength, and functional coordination of the back and trunk muscles. Individual instruction given by physical therapists 5 times during total study period of 13 months.	Training group (n=28) matched with a control group of aides/nurses (n=32) that received no exercise training. Data for both groups to include: 1) before/after measures of isometric back muscle strength, 2) number of complaints of low back pain and its intensity, and 3) number of days absent for low back problems.	None noted.	Training group as compared with controls: 1) increased back muscle strength by 20%; no change for control group, 2) logged fewer complaint days of back pain (53.9 vs. 94.3) and lesser pain scores, and 3) had only one lost-day case for low back problems (lasted 28 days); control group had 17, 4 lasting more than 14 days.	Authors note that every hour spent by physical therapist reduced work absences by 1.3 days, cost/benefit greater than 10. Weaknesses in study also mentioned. One was that psychosocial factors (training group getting more attention) could not be ruled out as affecting results. Second, since physical therapists doing the testing were not blind to the participants in each group, they could have biased the outcomes.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-IV. Control of Ergonomic Hazards

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
439 firefighters in a city department showing excessive days lost/costs from line of duty injuries, mostly musculoskeletal in nature. (Hilyer, Brown, Sirles & Peoples, 1990)	To employ flexibility and stretching exercises for the lower back, hamstrings, and shoulder muscles as a means of reducing musculoskeletal sprains and strain injury among firefighters.	Firefighters in 2 districts received flexibility training; those in 2 others served as a control. Handouts of 12 stretching exercises with instructions issued each firefighter. Each fire station scheduled 30 minutes per day for exercise supervised by exercise leaders previously trained by exercise physiologist in charge of overall program. The intervention period was 6 months.	The study design compared pre/post data on a battery of flexibility tests for firefighters in the training and control districts plus analyzed injury rate/cost data for the two groups in a 2-year period after the intervention. The flexibility battery included tests of sit-reach, trunk rotation, knee flexion/extension, shoulder flexion/ extension.	Letter from Fire Chief"s office used to establish the 30-minute exercise period in the district stations receiving training.	Pre/post battery data found the exercise program to increase the flexibility of the firefighters with sit/reach, shoulder flexion/extension, and knee flexion scores showing significant gains. Injury rate for the training group was 19.1 per 100 compared with 23.9 per 100 for the control group. Lost time dollar costs for the control group was 3× greater than that for the training group.	Authors suggest possible "Hawthorne" motivational influence in the improved flexibility scores of the training group relative to the control group whose post-test battery data showed decreased flexibility. Report does not state whether the exercise program was introduced later in the control districts, considering the apparent positive results.

A-IV. Control of Ergonomic Hazards

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
6 janitors engaged in extensive mopping tasks with frequent forward bending with increased stress on the trunk. (Hultman, Nordin, & Ortengren, 1984)	To give workers an understanding of simple ergonomic principles focussed on biomechanics of the spine and to practice reducing undue flexion and loading on the lumbar spine through adopting improved work techniques.	Training comprised 3 sessions. The first lasted 45 minutes and dealt with anatomy, muscle physiology, and biomechanics of the spine. The second and third sessions, each lasting 30 minutes, included slides of workers performing tasks in ways that put stress on the low back (through frequent, deep forward bending of the trunk in mopping work). Techniques to relieve this loading were shown, and the workers, while engaged in wet-mopping work, practiced them under supervision of physiotherapists in charge of the training.	Trunk flexion was measured using a portable battery-powered unit placed on the back of each of the 6 workers. The unit recorded angle of trunk bending, amount of time spent in specific angular position, and frequency of changes from one position to another. These measurements, along with worker ratings of perceived workload (Borg Scale) and questions on proper work techniques involving the spine, were taken 3 times, once before and twice after the training. The latter were at 1–4 days and 2–3 months post-training.	There was no feedback in this study nor mention of any other extra-training features.	Time workers spent in normal upright position increased from 42% pre-training to 67% immediately after training, and to 72% 2–3 months later. Workers reduced time in moderate, deep forward flexion positions by nearly 40% in both post-training sessions. The number of deep flexions also dropped significantly. Ratings of perceived workloads were in the mid-range, reflecting moderate to heavy industrial work and showed no change from pre- to post-training. Workers correctly answered all questions about proper work procedures regarding ergonomics at 2–3 month period.	It was not possible to determine which tasks were being performed with improved ergonomic techniques that resulted in less forward bending stress on the trunk. Speculation was it was from placing mop buckets on chairs or on carts so as to relieve bending; also bending knees in mopping rather than the back. Absence of finding ratings of lower perceived loads on the back with changes to less stressful movements believed to result from the short period of the actual testing (1 hour) and lack of scale sensitivity to the exertions involved.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-IV. Control of Ergonomic Hazards

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
1000 employees in select departments of an Air/Space company showing disproportionate costs and frequency of the firm's back injury problems. (Lepore,Olson, & Tomer, 1984; also reported in Tomer, Olson, & Lepore, 1984)	To enhance awareness of back injury problems, of both on- and off-the-job risk factors in their occurrence, and of ways to reduce the incidence of back injury through ergonomic work practices and lifestyle changes.	Physical therapist and safety engineer with line employees developed training materials based on worksite analyses targeting high problem areas. Separate training programs for specific departments were framed and reviewed with management and supervisors who were instructed in back injury prevention practices. Ergonomic and environmental ideas generated were shared with management at that time. Groups of 20–25 workers attended 1-hour classes in their work areas. Content covered anatomy, posture, physical fitness, and work and nonwork risk factors. 7 months later, the workers attended a 2nd 1-hour class with same instructor. Classes here ranged from 35–50; two had 150 in attendance.	Compare costs for back injury cases/prevention training before and after the two training sessions in terms of total expenditures, cost per claim, percent of lost time cases, and frequency of new cases.	Coincident with the back injury prevention training, the company's safety department also took steps to motivate increased supervsior involvement in the investigation and to report actual worker injury incidents or near misses.	Based on annual expenditures, costs of the back problems plus training costs post training were 67.5% less than pre-training. The cost per claim also dropped after the training by 76%. The % of back injury cases losing time after training was 19% as compared with 63% before training. The actual frequency of cases showed a slight increase that probably reflected the supervisor's new efforts to report injury mishaps.	Without more specifics, it is difficult to ascribe benefits to training program per se. Lacking is information on specific work practices, ergonomic measures that were developed and presented during training, how well were they implemented, and causal tie with the outcome measures. It is also unclear whether the reductions in injury cases/costs were in the original problem departments or for the company as a whole.

A-IV. Control of Ergonomic Hazards

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
6600 workers in a telecommunications plant involved in product assembly operations where excess chronic trauma disorders are apparent. (McKenzie, Storment, Van Hook,& Armstrong, 1985)	To inform plant supervisors and engineers of risk factors underlying chronic trauma disorders (CTDs) and how best to control them through engineering (i.e., job/tool/work station redesign), training, and medical management approaches.	Groups of 50 supervisors & engineers given lecture, slide presentations, and lab demonstrations to highlight CTD etiology/control measures plus in-plant observations of select problem operations. This was one element in a total program; others were engineering (job/tool/work station redsign), medical records review, and management of cases.	Comparisons of OSHA reportable injury rates for repetitive motion disorders for periods before and after the implementation of a task-force directed program.	Overall program was directed by a task force composed of members of the plant management, medical, industrial hygiene, and human factors groups.	Implementation of program coincided with a reduction in CTD cases. Before, OSHA reportable injury rate was 2.2 cases per 200,000 work hours and 1001 lost days; after establishment, there were 0.53 cases per 200,000 work hours and 129 lost workdays. Improved tool design/work layouts were noted as were earlier actions to prevent debilitating cases.	Training seen as influential to the outcome of the intervention, but the results, as presented, do not tie a particular program element to an outcome. Work provides an example of supervisor-professional level staff training in support of a programmatic-type effort.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-IV. Control of Ergonomic Hazards

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
33 newly hired and 60 experienced assembly line workers engaged in repetitive tasks (cycles of 5–6 minutes repeated 60–80 times per day) involving use of upper extemities. (Parenmark, Engvall, & Malmkvist, 1988)	To instruct workers in adjusting heights of work-benches, layout, and use of new tools in order to reduce biomechanical loading on the arm/neck-shoulder area, on the occasion of installing new ergonomically designed workstations and equipment.	New and experienced workers divided into a training and control group. Training consisted of 5–6 weeks of learning working techniques that would keep musculo-skeletal loads on the upper extremities below 10% of the maximum voluntary contraction level. Workers' level of effort monitored with EMG and adjusted until the the load fell below the 10% level. Control group had usual foremen instruction in job tasks.	Separate comparisons made between the trained vs. control groups of new and experienced workers on measures of number of sick leave days as reported over a 48-week period post-training.	None elaborated	For new workers, mean number of days of sick leave absence for upper extremity problems was more than 50% lower in the trained group than the control group and was statistically significant. Trained experienced workers also showed fewer sick leave days than did the controls, but the difference was insignificant.	Study shows that it is not enough to introduce ergonomically designed workstations for relieving problems, but it is important to ensure worker use of such equipment to maximize the benefit. Question of whether the positive results for the trained groups reflect greater interest in them (e.g., Hawthorne effect). The sick absence rate for all diagnosed problems among experienced workers in the trained and control groups was the same; this suggests that the Hawthorne effect was not a dominant one.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-IV. Control of Ergonomic Hazards

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
110 workers in a grocery distribution center reporting excess back injury cases (Schwartz, 1989)	To have supervisors and workers learn concepts of work simplification and energy conservation in materials handling tasks to reduce back injuries in their job operations.	Supervisors oriented in back injury prevention in job tasks followed by on-the-job instruction of workers in ways to reduce back stress in their work. Small group sessions held, special ones for those returning to work after a back problem.	Compare lost-time cases and costs for back injuries 6 months before and after the program was established.	Recommendations made to management dealing with operational changes and tool redesign to relieve back stress after the intervention.	Before/after 6-month comparisons showed a 39.4% reduction in lost-time injury cases.	Evaluation data lack specificity tying worker actions, as effected by the training, to the apparent decrease in back injury reports. Intervention stresses need for management involvment.
2 nurses from 2 wards requiring frequent patient transfer-movement tasks. (Scholey, 1983)	To make nurses aware of patient handling movements that cause peak stress on the back and ways to alleviate it through various actions (e.g., have patient move to edge of chair or bed to facilitate move).	Instruction focussed on 3 tasks identified as posing most severe stress in patient handling. Nurse trainees task behaviors in pre-training contrasted with other demonstrated techniques posing less back stress. A radio pill was swallowed to monitor intra-abdominal pressures in showing the differences in truncal stress. Training conducted over a 3-week period where nurse trainees were told to practice the prescribed behaviors.	Pre- and post-training measurements were made of intra-abdominal pressures while trainees (working in pairs) performed the 3 targeted tasks on select patients in each of the 2 wards.	Patients in the two wards differed in their willingness to cooperate in the transfers or turning tasks; this was a factor in the nurses ability to apply the instruction.	Intra-abdominal pressures for nurse trainees in one ward went down after training, reflecting a positive effect, but went up for nurses in the second ward—a negative result. 3 of the 4 nurses showed some reduction in pressures after training.	Authors indicate that only 3 weeks of training and lack of supervised practice may underly inconsistency in results. Also that patient conditions and level of their cooperation can complicate proper lifting techniques.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-IV. Control of Ergonomic Hazards

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
32 orderlies in four units of a geriatric hospital (St. Vincent, Tellier, & Lortie, 1989)	To demonstrate application of training given orderlies in lifting principles for patient transfer tasks.	12 hours of classroom and workplace courses covering theory and practice in proper lifting/handling. 6 major principles taught (e.g., back straight, knees bent, feet apart, pointed in direction of movement, etc.).	Observational grid developed to have independent raters score different elements in the task and method of handling a patient as performed by orderlies. Major operations observed included taking up and putting down patients plus 3 other in-place operations.	Physical constraints noted as precluding use of learned practices, especially those dealing with horizontal handling movements.	Majority of orderlies who were observed 12–18 months after training had 10 years experience. Grid showed that adherence to taught principles in ward units varied from 11-33%. Actual movements deviated as much as 89% from recommended postures.	Authors stress the inappropriateness of biomechanical principles as applied to patient lifting setting; see the bed as a problem location for handling; do not see the value of laboratory studies of lifting boxes as being related to patient lifting tasks. Question emphasis on use of legs in lifting (at least in this application) as opposed to distributing loads across different limbs.
8 nurses whose ward routines involved frequent lifting, transfer of patients. (Stubbs, Buckle, Hudson, & Rivers, 1983)	To determine which of 4 lifting methods is least stressful and its trainability/use in a ward setting.	4 methods compared were: shoulder lift, orthodox lift, through-arm lift, under arm drag. 8 nurses performed these lifts under supervision of trainer. Susequently, two nurses had one-on-one instruction with trainer in applying the lifts to 8 different patient-handling tasks in 4 sessions.	Intra-abdominal pressures (IAP) measured (via a radio pill) in rating back loads for the 4 lifting methods along with comfort scores. IAP pressures also measured for 2 nurses who performed 6 of the 8 patient handling tasks per instruction.	None elaborated.	Shoulder lift for moving patients produced significantly lower IAPs, with remaining 3 methods showing little difference. Shoulder and orthodox techniques also had higher comfort ratings. As measured 15 weeks after training, the 2 nurses IAP scores showed little difference from those taken early in training. In fact some had shown increase in jobsite tests.	Authors suggest that training to reduce lifting problems in patient hospital settings is ineffective. A broader ergonomic approach should be stressed.

A-IV. Control of Ergonomic Hazards

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
106 coal miners and 27 others deemed "experts" in coal mining tasks by reason of long-term work and instructional experience. (Symes, Graveling, & Campbell, 1992)	To determine if current training in handling heavy, awkward loads is correcting miner misperceptions of risks connected with these activities, and if not, where course changes are needed to cover shortcomings.	Miners and experts attended 1-week courses emphasizing safe ways to handle heavy, awkward loads. Few details given about the nature of the instruction. Indication that discussion is on mechanical factors of transport, i.e., use of slings and lifts. Training focussed on risk of musculoskeletal disorders and other hazards in handling heavy, awkward loads in coal mining.	Miners and experts each rated the risks presented by 13 heavy, awkward load situations at pre-training, at the end of the 1-week course, and in a follow-on session 10 weeks later. In addition, tests designed to measure locus of control of one's action (internal vs. external) and tendencies toward absentmindedness (cognitive failures) were administered.	None elaborated.	Miners, and experts' ratings were similar for 3 actions rated highest in risk. For 10 others, the miners' post-course ratings showed shifts to increased riskiness akin to or greater than expert ratings. However, follow-on ratings revealed some reversals. Shifts to more internal control of actions correlated with upward shifts in riskiness and a decrease in mishaps and error tendencies.	The report includes a similar approach for using risk ratings for miners vs. experts as a means of assessing the effect of training for other manual materials handling tasks. However, no data were supplied to demonstrate its use in this case.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-IV. Control of Ergonomic Hazards

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
199 student nurses receiving instruction in patient handling techniques for reducing risk of back injury problems. (Troup & Rauhala, 1987)	To increase skill levels of nurses undertaking patient transfer tasks through special ergonomic instruction addressing factors such as the size/shape of patient, their level of dependency, availability of assist devices, and strengths of the nurse doing the transfer.	106 student nurses in 2 groups received 40 hours of theory and practical teaching in ergonomics in patient handling over a 5-semester period. Instruction included self-evaluation by students of videotapes of their patient handling skills, practice in teaching the skills they had learned, and keeping a diary of their patient-handling activities. 93 other nurses, in 2 groups, received traditional training in patient handling, with less emphasis on ergonomic factors.	Skill training assessed via student performance in two patient transfers that were uniform in terms of bed features, lay-out, handling aids, etc. Course instructor, an independent expert, and students rated each student in 1) preparation for the lift, i.e., selection of technique, choice of handgrip, posture at outset, 2) timing, loading of back and smoothness of lift in the actual move, and 3) completion of transfer, lowering patient, and relaxation.	See Comments column regarding potential extra-training concerns.	The three types of raters each gave significantly higher skill marks for the students receiving the ergonomics instruction than for those having the traditional training.	Results tempered by the following points: 1) performance based on an examination and may not reflect patient-handling practices as adopted by nurses under more routine conditions; 2) because senior nurses in charge of wards may lack similar instruction, the skills taught may not be reinforced or properly supervised. Argues for beginning the training programs with the more senior staff.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-V. Control of Health Hazards—Biologic Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
700 health care workers, particularly those engaged in non-direct hospital inpatient services (e.g., housekeepers, dietary workers, laundry workers, nurse's aides) whose workplace risks include exposures to HIV and other infectious agents. (Askari & Mehring, 1992)	Via a union-supported train-the-trainer program, to 1) enhance worker knowledge of occupational risks from exposures to blood/body fluids at the worksite, 2) develop strategies to reduce the risks, 3) discuss feelings about caring for HIV/AIDS patients, and 4) hold workshops for covering the above on return to one's worksite.	Main features were 1) a train-the-trainer approach, 2) aimed at non-professionals not typically covered in HIV/AIDS instruction, and 3) an education for action method built on trainee experiences and concerns, and discussions of problem-solving ideas and how they can be effected through employee action. The 2-day sessions employed case studies, small group exercises, role-playing, audio-visuals and other means to promote worker involvement, and plans for follow-on workshops that they would hold. Subsequently, these 100 worker-trainers used similar techniques to lead AIDS/HIV workshops with 600 health care workers.	Pre and post tests were used to assess "trainers to be" knowledge of subject matter and merits of the program. Post-training competency was also tested in those workers attending workshops of the “trainers.” Reports of the trainers summarized their experiences.	Assistance was given the worker-trainers when they went back to their workplaces by supplying videos and HIV/AIDS materials. However, efforts by worker-trainers to train others in their departments met resistance by superviors who believed them unqualified.	Union trainer scores on knowledge of basic information on HIV/AIDS transmission and prevention increased from 80% pre- to 92% post-instruction. The overall quality of the program, its materials, and method of instruction was graded excellent. From workshops held by these trainers, attendees, post-test competency scores were 90%. Trainer reports of the workshops indicated that they had difficulty getting people away from work and needed more time to cover topics. The trainers believed they were ill-equipped to handle prejudices about people with AIDS/HIV that also surfaced.	Feedback to workshops indicated that hearing information from union trainers and co-workers had greater credibility than from the infection control officer. Still, gains in knowledge and positive reactions to programs do not ensure follow through in terms of behaviors and new work practices that can reduce the risk. Evaluation methods need strengthening.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-V. Control of Health Hazards—Biologic Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
144 nurses (101 RNs, 43 LPNs) at two university-affiliated VA medical centers engaged in tasks involving exposure to blood/body fluids. (Goldrick, 1989)	To compare the effectiveness of a self-managed, programmed unit of instruction versus a lecture mode in educating nurses on principles of infection control regarding hepatitis B and HIV exposure risks.	Instructional material for programmed learning developed as series of frames arranged in heirarchial order on topics of the infection process, routes of transmission, risk factors, and types of precautions and applications. Similar information given in lecture. Nurses grouped into the two learning modes for making comparisons.	An identical 10-item forced-choice quiz was given during the pre- and post-test to measure knowledge gain from each type of learning mode. Time taken to cover material and preference for instruction also noted. Years of experience and education assessed with regard to influence on the results.	None elaborated.	Both modes showed significantly better post-test scores, but those for the programmed learning group were higher than those in the lecture group, regardless of educational level or experience. The programmed learners also took half as much time to complete the material and showed a preference for this method of inservice training. Years of nursing experience varied inversely with the perceived complexity of the programmed material.	The question remains of how much of this training effect is translated into control actions. How durable is the knowledge gain from either form of instruction?

A-V. Control of Health Hazards—Biologic Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
3100 employees in a university hospital who were subject to three intervention efforts for reducing needle-stick injuries as part of an infection control program. Education was one such effort (Linnemann, Cannon, DeRonde, & Lanphear,1991)	To stop recapping of needles and their improper disposal as a means of reducing the incidence of needle-stick injuries; also to enhance the reporting of all such injuries for follow-up laboratory testing for hepatitis and HIV.	Infection control department furnished information to all nursing personnel and new hospital workers on risks of needle-stick injuries and bloodborne infections and on ways to decrease the risk. Among other behavioral actions, avoiding recapping was stressed. Needs for reporting such events also stressed in light of health risks. Educational effort later augmented by placing sharps containers in each patient room and instituting universal precautions that reinforced the dangers of needle-stick injuries and prevention.	Hospital maintained a surveillance system for tracking needle-stick injuries by employee groups and had the system in place before, during, and after the education intervention. Such injuries also noted after placing sharps disposal units in patient rooms, and after introducing universal precautions practices. Those reporting injuries also completed questionnaires as to the circumstances (i.e., while recapping, needle in trash, linen, etc).	None noted.	Pre and post differences in needle-stick injuries just after the education effort showed a rise in cases (51 per 1000 vs. 67 per 1000 employees) believed due to increased reporting. The injury rate (50 per 1000) decreased when sharps containers were installed and remained at that level for the universal precautions. Nurses were most afflicted group; their needle-sticks from recapping did not drop below 15% despite three intervention efforts.	Authors provide little detail as to the nature of the education program used. They do note that more direct monitoring of workers recapping practices may be a means for reinforcing the instruction. Mention is made of providing direct feedback to managers in areas where injuries have occurred to encourage their particpation in the prevention process.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-V. Control of Health Hazards—Biologic Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
964 employees of a medical center including clinical staff, laboratory technicians, and housekeepers taking part in a program aimed at generic infection control (Lynch, Cummings, Roberts, Herriott, Yates, & Stamm, 1990)	To enhance employee knowledge of infection control and adoption of more stringent barrier practices (i.e., use of gloves/masks/gowns) and compliance with upgraded containment/disposal measures as part of a program aimed at body substance isolation.	Practices of various departments revised to conform with new, explicit recommendations. Preliminary discussions held to resolve potential difficulties. 50 training sessions run, each a 45-minute slide and discussion offering. Attendance varied among the various staff groups; at end of training, about 75% of clinical staff attended and 51% of workers in other categories.	Evaluation used a pre and post training approach and included 3 measures: 1) written test just before and after the training to ascertain infection control knowledge, attitudes and self-reports of work practices; 2) direct observation of compliance with recommendations for glove use; and 3) monitoring the colonization and infection of hospitalized patients with marker organisms.	Total program of body substance isolation had support of medical staff leadership and hospital administration. Importance seen in that compliance with the new procedures was made part of an employee's performance review in some departments and later adopted by others. Barrier practices required added supplies (glove boxes, disposal containers), which were obtained.	1) Scores on the questionnaire indicated statistically significant increases in knowledge. Staff responses also showed over 90% knew of prescribed glove use for infection control before the training, but less than 75% admitted conformance. 2) Proper glove use, judged by direct observations for 2 months before and 3 months post training, found overall improvement of 20%; for some groups the gain was 50%. 3) Markers for nosocomial colonization and infection in clinical specimens showed a sharply declining rate for 3 post-training years.	Authors note that involving key personnel early in the decison-making and training process was critical in gaining acceptance of the total program. Mention made of role of head nurse as instrumental to the success of the program.

A-V. Control of Health Hazards—Biologic Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
759 California health care providers given teaching instructions and learning about AIDS; they in turn taught 18,879 other health care workers on the same topic. (McCarthy, Schietinger, & Fitzhugh, 1988)	To increase health care providers knowledge about HIV infection, allay unwarranted fears about AIDS, provide innovative ways to instruct others in understanding and controlling this disease, and to enable health care persons to become AIDS education resource persons in their own communities.	Train-the-trainer approach used adult education concepts (stress self-direction, experiential reference, task-centered techniques) in a 2-day program covering 8 topics (e.g., attitudinal factors in teaching/learning, HIV infection, transmission and control, adult learning principles). 27 sessions of 30–35 participants were held. Attendees later gave 1–3 hours of AIDS education to health care workers in their communities.	20-item written test at the end of the 2-day program for the trainers to assess their knowledge of adult education and HIV infection. Those in the follow-on HIV education programs took a written post-test containing 14 true/false questions on HIV transmission, prevention, and screening. In addition, qualitative reviews offered by a minority AIDS task force on course relevancy. A research agency polled trainers on adequacy of preparation.	None elaborated.	Trainers scores on the post-test found 88% achieving a rating of 90% or higher. For those attending the HIV education sessions of the trainers, 73% achieved 90% or higher scores on one version of the true/false post-test; and 92% scored above 90% on a revised version. Qualitative review indicated needs for using case studies involving minority members to make material more relevant to user groups. Trainers felt capable as AIDS instructors; main problem was gaining release time for workers to attend classes.	Study concept was excellent in terms of learning approaches and train-the-trainer means for delivering the instruction to a needy audience in a short time period. The evaluation plan seems the major limitation to the study, i.e., no pre-test or control group to compare with post-test scores for knowledge gain or other indicators to show the effect.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-V. Control of Health Hazards—Biologic Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
208 nurses in a 135-bed hospital on the occasion of introducing new sharps boxes and a policy to discontinue needle recapping. (Seto, Ching, Chu, & Fielding, 1990)	To have nurses forgo recapping of needles and therein reduce the incidence of needle-stick injury and risk of blood-borne disease transmission.	Three methods compared to inform/encourage nurses to adopt a new needle disposal policy. Method #1: policy communicated via charge nurses of wards; Method #2: charge nurse announcement plus posters and pamphlets given each nurse in ward; Method #3: same as Method #2 but also half-hour in-service talks on pamphlet by infection control officer.	9 wards randomly selected/divided into 3 groups, each subjected to one of the three methods. Before new disposal policy introduced, each nurse asked about their needle recapping practices, the merit of using sharps boxes for disposal, recapping risk, and safest needle disposal practice. 5 weeks after policy announcement, this inquiry was repeated. 1 day before repeat inquiry, sharps boxes used in a 24-hour period collected unannounced in wards, and number of uncapped/recapped needles counted.	None elaborated.	Post policy comparisons found 85% of nurses from Method #3 wards to report no recapping, followed by 66% from Method #2 wards, and 27% from Method #1 wards. This order correlated with 57%, 47%, and 26% of the needles found in the sharps boxes that were found uncapped for nurses in Methods #3, #2, and #1 wards, respectively. Self-reported behavior changes were greatest for those nurses scoring highest on the concept questions after the policy announcement.	Authors suggest that educational efforts that ensure appreciation of concepts prepare the way for associated behavior change. Presumably, Method #3 provided for that experience, which is referred to as more active in nature. Short follow-up period (5 weeks) and a single time point for evaluation raises question about the durability of the findings.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-V. Control of Health Hazards—Biologic Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
1,247 health care providers (mostly nurses but lab technicians and hospital support staff also included) whose jobs could include administering to AIDs cases. (Wertz, Sorenson, Liebling, Kessler, & Heeren, 1987)	To educate providers in ways to protect themselves from getting AIDS in the course of their jobs, to feel comfortable in caring for AIDS patients, and to discharge the highest quality services.	90-minute sessions held at 36 sites in Massachussetts. Lecture/discussion format addressed epidemiology of AIDS, modes of transmission and prevention, general infection control procedures, and psychosocial concerns. Added feature was either a physician talk on latest AIDS research or an AIDS-infected patient describing illness.	Questionnaire used before session, immmediately after session, and 1 month later to obtain data on trainees knowledge of AIDS transmission and means for control and on attitudes and competency in treating AIDS patients.	None elaborated.	Post-session data showed knowledge gains in 7 of 15 modes of transmission and 7 of 11 means of infection control; sizeable percentages still held mistaken beliefs about contacting AIDS. Post-session attitude shifts were toward more comfort and ability to handle AIDS cases. Sub-analyses found those who established regulations for care of patients and out-patient/providers to have more accurate knowledge and assurance in handling AIDS cases; the inpatient providers, the least. 1-month follow-up revealed no change.	Results suggested needs for further education of health care providers as a group and different instruction for those at different levels. Educational offering was able to shift attitudes in positive direction, but this approach was not able to eliminate all differences between the subgroups of providers.

TRAINING INTERVENTION STUDIES AS FOUND IN THE LITERATURE ADDRESSING VARIOUS TYPES OF OCCUPATIONAL HAZARDS

A-V. Control of Health Hazards—Biologic Agents

Work Setting Operation (Ref)	Training Objective	Training Plan	Evaluation Method	Extra-Training Factors	Results	Comments
277 physicians in two hospitals whose job routines include exposure to patient blood and body fluids. (Wong, Stotka, Chinchilli, Williams, Stuart, & Markowitz, 1991)	To promote compliance with policies on use of universal precautions as prescribed by CDC and mandated by OSHA.	Slide/lecture sessions (up to 1 hour in length) held on etiology of HIV and hepatitis B, transmission modes, and risk of infection. Barrier devices, waste disposal, use of cleaning agents, and reporting of needle-stick injuries explained. Added education through grand rounds, conferences.	Physicians completed forms describing each incident of potential or actual contact with a patient's body fluids. Use of protective devices (gloves, gowns, masks) noted and whether they had averted direct contact with the fluid. Forms filled out daily, and entries compared for 3–4 months before and after the training period.	Barrier devices were stocked in a central location in each ward and restocked daily. Each patient room supplied with a box of examination gloves and puncture-proof box for sharps disposal. Signs on universal precaution policies mounted at the central nurses station. Follow-up memo in one hospital on precautions.	Barrier use during fluid exposure incidents increased from 54% before implementation to 73% afterwards. Rates of direct exposure contacts decreased by 52%; and use of barriers was found to avert direct contact events at a rate 50% greater than before. The rate of needle-stick injuries also dropped by 62%.	Results impressive but based on physician self-reports, not on direct observations. Data identify procedures where exposure/contacts are problematic and need study to reduce risk. Authors indicate that gloves were main factor in efficacy of the precautions, and increased access to barrier devices were also a key to success of the implementation.

APPENDIX B*

EXTRACTS FROM BUREAU OF LABOR STATISTICS (BLS) WORK INJURY REPORTS FOR DISCERNING REAL/POSSIBLE GAPS IN JOB SAFETY/HEALTH TRAINING

Data Base-Sample Surveyed (Period of survey)	Limitations in Extent/Nature of Training					Follow-up Actions/Needs
	Form/Source of Trng.	Training Content	Workforce Coverage	Date of Last Trng.	Age/Job Experience	
1400 respondents to survey of 2000 workers with reportable injuries from ladder mishaps. (Winter, 1978)	73% not provided written instructions on safe use of ladders. 78% trained on-the-job.	66% lacked training in how to inspect ladders.	59% lacked training on use of ladders.	Of those noting training, 50% indicated it took place over 1 year ago.	Most injuries in 25- 34-year old group (25%).	
803 respondents to survey of 1230 workers with reportable injuries from scaffold mishaps. (Summer,) 1978	On-the-job training noted by 62%–71% in learning different safety requirements; over 50% by just watching others	Safety requirements covered for scaffold assembly, planking, inspection, weight limits, guard rails; no more than 71% noted training in any topic.	26%–35% of respondents indicated no training in any of the topics noted in the content column.	71% indicated training received more than 1 year ago; 71% from other than the current employer.	Highest % of injured in 25–34 year old group (24%); next was 20–24 year olds group (18%).	
1364 respondents to survey of 2300 workers with injuries from welding/cutting operations (July-November, 1978)	Both on-the-job and classroom training noted, but not more than 37% received either form of such training.	81% believed subject coverage adequate but coverage of different topics ranged from 40% to 83%.	30% indicated they learned welding/cutting safety on their own through job experience. 11% never had any safety training.	69% of those receiving training noted the date of more than 1 year ago.	26% had less than 1 year of work experience; 16% less than 6 months. 25–34 year old group had greatest % of injuries (32%).	
1746 respondents to survey of 2300 workers with reportable injuries from power saw use. (September–November, 1978)	On-the-job and classroom instruction were main forms of training, but each noted for no more than 39% of the worker respondents.	For those receiving training, coverage of various topics drew response rates varying from 32% to 59%.	39% learned power-saw safety through their own job experience. 17% never had any safety training.		44% working with saw less than 1 year; 19% less than 1 month. 20–24 year old group and 25–34 year old group tied for highest % of injuries (25%).	

***The shaded entries in the tables are meant to suggest major training deficits for sizeable percentages of the afflicted workers. See Pages 35–37 of the main text for a discussion of these findings.**

APPENDIX B *(Cont'd)*

EXTRACTS FROM BUREAU OF LABOR STATISTICS (BLS) WORK INJURY REPORTS FOR DISCERNING REAL/POSSIBLE GAPS IN JOB SAFETY/HEALTH TRAINING

Data Base-Sample Surveyed (Period of survey)	Limitations in Extent/Nature of Training					Follow-up Actions/Needs
	Form/Source of Trng.	Training Content	Workforce Coverage	Date of Last Trng.	Age/Job Experience	
1033 respondents to survey of 1881 workers with reportable head injuries at work (July-September, 1979)	Information on "hard hat" protection mainly from supervisor or safety officer (81%), but co-worker (19%) and printed material (25%) also noted.	Instruction emphasized when and where to use (61%); other topics such as how to adjust, maintain, and types available drew less than a 35% response.	32% received no information or instruction on "hard hats."		20–24 year old group had highest % of head injuries (32%).	In head injury cases, 41% of the respondents did not know of any action employers took to prevent recurrence. Where noted, accident investigation and issuance of warnings were main (33%) follow-up actions. Training noted at 1%.
1251 respondents to survey of 2005 workers with reportable foot injuries at work (July–August, 1979)	Given information on safety shoes from supervisor or safety officer (92%).	Information stresses where/when to wear (41%); coverage of features available, maintenance, and advantages ranged from 6% to 17%.			Most foot injuries in 25–34 year old group (26%) followed by 20–24 year old group (23%).	Fewer than 25% wearing safety shoes at time of accident though 72% aware of company policy on wearing shoes in specific areas and jobs. 21% indicated employer took no follow-up actions after injury; 28% did not know of any.
1052 respondents to survey of 2118 workers with reportable eye injuries at work (July-August, 1979)	Main instruction on eye protection from supervisor or safety officer (91%); co-workers (14%) and classroom session (14%) also noted.	Subjects of where and when to wear drew a 72% response; followed by type to wear (39%). Care and limitations had a 16% response.	20% of respondents had no instruction in use of protective eyewear.		25–34 yr group had highest % of eye injuries (32%). Next was 20–24 year old group (25%).	Though over 70% of workers indicated company policy on wearing eye protection, more than 20% noted enforcement came after injury. Common response to nonuse was impractical or not required.

APPENDIX B *(Cont'd)*

EXTRACTS FROM BUREAU OF LABOR STATISTICS (BLS) WORK INJURY REPORTS FOR DISCERNING REAL/POSSIBLE GAPS IN JOB SAFETY/HEALTH TRAINING

Data Base-Sample Surveyed (Period of survey)	Limitations in Extent/Nature of Training					Follow-up Actions/Needs
	Form/Source of Trng.	Training Content	Workforce Coverage	Date of Last Trng.	Age/Job Experience	
774 respondents to survey of 1323 workers with reportable facial injuries (struck by object/contact with chemicals) received at work (July–November, 1979)	Instructions on face protection came from supervisor or safety officer (79%); classroom instruction noted at 33% and co-worker at 22%.	Topics of when and where (39%) and type to wear (23%) drew most response. Fitting (14%), care (16%), and limitations (17%) also noted.	Nearly 60% of respondents indicated no instruction in use of face shields or welding helmet.		25–34 year old group had highest % of facial injury (32%); the 20–24 year old group was next (26%).	Company policy on required face protection noted by 50% of respondents. When asked why no face protection worn at time of mishap, 56% indicated impractical.
833 respondents to survey of 1285 workers with reportable injuries from servicing jobs (August–November, 1980)	What training was noted was on-the-job (32%).	Responses to training in various facets of lock-out procedures ranged from 87% (when to lockout) to 9% (clearing area).	61% indicated no training in lockout procedures.	32% indicated training in lockout occurred over 1 year before injury; 45% upon hiring. 8% had instruction after the accident.	38% had job duties for a year or less; 22% less than 1 month.	74% did not know of any company policy on lockout requirements.
906 respondents to survey of 1900 workers with reportable back injuries while engaged in lifting tasks (November–December, 1980)	48% noted information on lifting gained from posters; 35% indicated on-the-job training. Response to lecture, demonstration, and film were 21%–32%. Supervisor or safety officer was source of information for 81%; co-worker for 16%.	44% noted information received on how to lift to avoid injury. Other means for reducing risk (use of hoists/carts, rest breaks) showed no more than 13% response.	51% of respondents indicated no information given on proper lifting or moving procedures.	34% indicated training offered within past 6 months of accident occurrence; 55% within the past year.	25–34 year old group showed highest % of injuries (33%); 20–24 year old group was next (21%).	50% of respondents believed training insufficient to prevent injury. 40% of workers indicated that employer took no action and 42% knew of no action to prevent recurrence. Training on how to lift was noted by 6%. Equipment, job redesign alternatives drew less than a 5% response.

APPENDIX B *(Cont'd)*

EXTRACTS FROM BUREAU OF LABOR STATISTICS (BLS) WORK INJURY REPORTS FOR DISCERNING REAL/POSSIBLE GAPS IN JOB SAFETY/HEALTH TRAINING

Data Base-Sample Surveyed (Period of survey)	Limitations in Extent/Nature of Training					Follow-up Actions/Needs
	Form/Source of Trng.	Training Content	Workforce Coverage	Date of Last Trng.	Age/Job Experience	
Two surveys reported. (**Survey I**) involved 944 respondents from sample of 1865 workers with reportable hand injuries for the period (January–April, 1981; (**Survey II**) involved 861 cases of hand/arm/finger amputations from a sample of 1528 workers for the period December 1980–May 1981.	**Survey I**: 67% indicated information on hand protection given by supervisor; 31% by co-worker, 21% by safety officer.	**Survey I**: Topics were when and where to use gloves, specific type to wear, and merits of wearing, but no response greater than 23%; 27% of workers did not know or believe information sufficient to choose proper hand protection.	**Survey I**: 59% of respondents indicated no information received on use of safety gloves or other arm/hand protection. 11% indicated instruction was insufficient. **Survey II**: 59% indicated no safety training on task where amputation occurred.	**Survey II**: 27% of workers with less than 1 year of experience had any safety training; 51% with more than 1 year experience lacked for safety training.	**Survey I**: 25–34 year old group had highest % of injury (30%); 20–24 year old group next at 21%. **Survey II**: 25–34 year old group had highest % of injuries (26%); 10% of those injured engaged in work for the first time; 14% noted they seldom do this work.	**Survey I**: Regarding training issues: workers believed changes in work procedures (7%), lack of task instructions (8%), and unfamiliarity with tools (5%) contributed to mishaps. **In Survey II**, 11% of injured indicated employers conducted safety training and reviewed procedures as follow-up to injury event. **Survey I & II**: Almost half of the workers believed no action was taken or knew of none.
1041 respondents to a survey of 2313 workers with reportable injuries from oil/gas drilling work (May–August, 1982)	On-the job training was most common (80%), followed by safety meetings (50%), printed materials (31%), and class instruction (24%). 51% of workers noted training from previous supervisor and 28% from co-workers.	75% noted training in use of personal protective equipment; training on respirators received least response (28%).	21% indicated training did not cover safety procedures for job worker was doing when injured.		25–34 year old group showed highest % of injuries (38%); 20–24 year old group next with 30%.	Among factors contributing to accidents re training issues, workers noted incorrect instructions (2%), recent change in work routines (6%), and unaware of hazards (15%).

APPENDIX B *(Cont'd)*

EXTRACTS FROM BUREAU OF LABOR STATISTICS (BLS) WORK INJURY REPORTS FOR DISCERNING REAL/POSSIBLE GAPS IN JOB SAFETY/HEALTH TRAINING

Data Base-Sample Surveyed (Period of survey)	Limitations in Extent/Nature of Training					Follow-up Actions/Needs
	Form/Source of Trng.	Training Content	Workforce Coverage	Date of Last Trng.	Age/Job Experience	
1086 respondents to a survey of 1810 workers in the logging industry with reportable injuries (April–June, 1982)	Loggers noted supervisor source of training (29%); followed by a relative (16%) and co-worker (11%).		51% of injured loggers indicated no safety training.		13% of loggers had less than 6 months experience; 22% no more than 1 year in such work. 25–34 year old group with highest % of injuries (38%).	Regarding training: loggers noted factors contributing to injury such as wrong cutting method (6%), unaware of certain hazards (14%), and misjudgements (15%).
774 respondents to a survey of 1433 workers with reportable injuries resulting from falls from elevations (December 1981-June 1982)	75% indicated that training on how and when to use fall protection not provided by company.				25-34 year old group had highest % of injuries (31%).	Regarding training issues in injury occurrence: 22% of workers noted lack of hazard awareness. Others were: Need for more/better safety training (10%), use of safer work procedures (43%), and better company enforcement of such actions (21%).

APPENDIX B *(Cont'd)*

EXTRACTS FROM BUREAU OF LABOR STATISTICS (BLS) WORK INJURY REPORTS FOR DISCERNING REAL/POSSIBLE GAPS IN JOB SAFETY/HEALTH TRAINING

Data Base-Sample Surveyed (Period of survey)	Limitations in Extent/Nature of Training					Follow-up Actions/Needs
	Form/Source of Trng.	Training Content	Workforce Coverage	Date of Last Trng.	Age/Job Experience	
658 respondents to a survey of 1241 contruction laborers with reportable injuries (October, 1983)	34% received training from present supervisor, 28% from prior one, and 21% from co-worker. On-the-job training noted for 51% of laborers; 49% indicated vocational/technical courses in school on job safety/health topics.	Information on health hazards (e.g., asbestos) given to only 22%–23% of workers. Vocational /technical courses covering topics such as use of protective equipment or recognition of unsafe/toxic conditions were noted by from 25% to 69% of the workers.	26% of workers noted that they never received any training for the work done at the injury event. 33% indicated they never received safety instructions of any kind. 77%–78% indicated no information given on exposures to hazardous materials such as asbestos.		74% of the injured laborers had less than 1 year's experience. More than one half of the injured workers had been at a particular jobsite for less than 6 months. 12% suffered injury on the first day at the site. 25–34 year old group had the highest % of injuries (36%); the 20–24 year old group was next (32%).	Regarding traininig factors of consequence to injury event or its avoidance: Workers noted gaps in hazard recognition (14%), improper job instruction (3%), use of safer job procedures (21%), better safety training (8%), and company enforcement of safe work practices (11%).

APPENDIX B *(Cont'd)*

EXTRACTS FROM BUREAU OF LABOR STATISTICS (BLS) WORK INJURY REPORTS FOR DISCERNING REAL/POSSIBLE GAPS IN JOB SAFETY/HEALTH TRAINING

Data Base-Sample Surveyed (Period of survey)	Limitations in Extent/Nature of Training					Follow-up Actions/Needs
	Form/Source of Trng.	Training Content	Workforce Coverage	Date of Last Trng.	Age/Job Experience	
424 respondents to a survey of 770 workers with reportable injuries from warehousing type jobs (September, 1984)	On-the-job training noted by 32% of injured workers; printed materials (22%), safety meetings (20%), and films (18%) also checked as modes for receiving safety training. 30% also noted a labor-management committee on safety issues.	Safety training received by injured workers covered use of forklift trucks (23%), other powered equipment (13%), manual lifting techniques (28%), and housekeeping (29%). Written safe job procedures for the work done when injured was noted by 4% of respondents.	46% indicated no training for the job being performed when injured. 48% noted they never received safety training of any kind.		21% of those injured had been in warehousing work for no more than 1 year, and 43% of these workers had been with the employer for no more than 1 year at time of injury.	Regarding training factors of consequence to the injury or its prevention: workers noted correcting job instructions (2%), enhanced use of safe work practices (19%), better enforcement of rules (8%), greater use of lifting/handling equipment (5%). 41% of worker noted that no employer actions were taken after the injury event.

APPENDIX B *(Cont'd)*

EXTRACTS FROM BUREAU OF LABOR STATISTICS (BLS) WORK INJURY REPORTS FOR DISCERNING REAL/POSSIBLE GAPS IN JOB SAFETY/HEALTH TRAINING

Data Base-Sample Surveyed (Period of survey)	Limitations in Extent/Nature of Training					Follow-up Actions/Needs
	Form/Source of Trng.	Training Content	Workforce Coverage	Date of Last Trng.	Age/Job Experience	
381 respondents to a survey of 582 workers with reportable injuries in longshoring work. (October 1985; April 1986)	50% indicated company as source of training; other sources were union (44%), gang foremen (16%), superintendent (9%).	Training topics covered safe operation of trucks and forklifts (24%), cargo handling (20%), crane/winch use (10%), and union-management responsibilities (17%).		59% indicated that they have not had training in the past 3 years.	Bulk of injured workers (82%) had 5 years or more service in job category where event occurred; 75% with 10 years or more in longshoring work. Age group 35–44 years had highest % of injured (29%); 45–54 year old group next (27%).	94% of workers believed safety training could have avoided accidents. Workers rated enforcement of safety rules as usually-62%; sometimes–21%; hardly ever–8% and not at all–9%. Regarding training factors for accident prevention: workers noted need for co-worker receiving better training (10%), personally using safer work procedures (9%), and better housekeeping (5%).

APPENDIX B *(Cont'd)*

EXTRACTS FROM BUREAU OF LABOR STATISTICS (BLS) WORK INJURY REPORTS FOR DISCERNING REAL/POSSIBLE GAPS IN JOB SAFETY/HEALTH TRAINING

Data Base-Sample Surveyed (Period of survey)	Limitations in Extent/Nature of Training					Follow-up Actions/Needs
	Form/Source of Trng.	Training Content	Workforce Coverage	Date of Last Trng.	Age/Job Experience	
199 respondents to a survey of 395 workers with chemical burn injuries experienced on the job (May–August, 1985)	Supervisor, employer, or safety officer noted as source of hazard information (28%); the next sources were product label (9%) and co-worker (5%). Written instructions on use of chemical-resistant equipment noted by 7% of afflicted.	Main topic was where/when to wear protective equipment (28%). Fewer workers noted training on topics of types of protective equipment (5%), or their limits or advantages (7%).	67% did not receive any kind of information on wearing protective equipment. 61% indicated no written or printed instructions from employer on safe work practices in handling chemicals in use.		25–34 year old group had highest % of injuries (37%); next was the 20–24 year old group with 28%.	Regarding training factors of consequence to injury occurrence or prevention: Workers noted lack of hazard awareness (17%), wearing wrong type of equipment (12%), no job instructions (3%), needs for using safer procedures (34%), better safety training (15%), and improved company enforcement of safe work procedures (18%). **Note**: This survey was before enactment of the Hazard Communication Standard requiring employers to transmit information to workers through labels, material safety data sheets, and special training.

APPENDIX B *(Cont'd)*

EXTRACTS FROM BUREAU OF LABOR STATISTICS (BLS) WORK INJURY REPORTS FOR DISCERNING REAL/POSSIBLE GAPS IN JOB SAFETY/HEALTH TRAINING

Data Base-Sample Surveyed (Period of survey)	Limitations in Extent/Nature of Training					Follow-up Actions/Needs
	Form/Source of Trng.	Training Content	Workforce Coverage	Date of Last Trng.	Age/Job Experience	
256 respondents to a survey of 474 workers with reportable heat burn injuries (from contacts with hot objects/materials) on the job (May–August, 1985)	Supervisor, employer, or safety supervisor, was information source on use of burn protective equipment for 82% of afflicted; co-worker (18%) and printed instructions on protective gear (17%) also noted as sources.	19% of afflicted did not know if company had policy on wearing protective equipment. 17% indicated equipment being used was not designed to protect against heat burns.	55% of afflicted workers indicated no information provided on wearing protective equipment.		35% of injured workers had no more than 1 year service with employer; 19% had six months or less. 25–34 year old group had greatest % of injuries (37%), next was 35–44 year old group with 24% followed by the 20–24 year old group with 16%.	Regarding training: workers believed injuries could have been averted through use of safer work procedures (25%), better hazard warnings (7%), and effective company enforcing safe work practices (10%).