2005

Safety Training: Flowchart Model Facilitates Development of Effective Courses

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Safety Training

Flowchart model facilitates development of effective courses

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FEW SH&E PROFESSIONALS HAVE TIME to keep up with the voluminous literature about safety and health training. An easier strategy involves adopting a model of the training process, such as the one described in this article. The model is presented as a flowchart to show the relationships among the component processes for all safety and health training. It is intended to be a flexible model, suitable for tailoring to organizational needs, and easy to conceptualize. By learning this model, SH&E professionals will have a solid understanding of the processes involved in developing and implementing an effective safety training program.

The Training Process

Training helps employees acquire the knowledge and skills needed to perform their jobs safely. Safety and health training helps them understand standard operating procedures, potential hazards, appropriate protective measures and proper responses to unplanned, undesired events. In addition to these behavioral forms of hazard control, training complements engineering approaches by influencing behaviors that help maintain the controls as designed and installed.

Effective safety and health training benefits all involved. Workers gain needed skills and knowledge. Employers meet legal obligations and prepare employees to conduct their functions while avoiding frequent undesired events, traumatic injuries and occupational diseases.

To maximize these benefits, SH&E professionals involved in developing and conducting training should be familiar with the training processes recommended by experts in training systems. By understanding these processes and their interrelationships, SH&E professionals can solve several training-related problems. For example:

- Organizations may conclude that safety and health training can solve a specific problem before considering possible engineering solutions.
- Trainers focus too much on the subject matter and too little on what trainees need to learn.
- In developing new training modules, some trainers choose the lecture format (typically supplemented by a PowerPoint presentation) before seriously considering other learning activities that might be more effective.
- Course evaluations fail to provide documentation that trainees learned from the course.
- Training courses are longer than necessary and, therefore, more expensive than necessary because the focus of training is not clearly defined.
- Safety trainers discover a weakness in their process for documenting continuous improvement as required for special recognition by state, federal or international organizations and agencies.
- Training courses may be conducted without necessary equipment, suitable facilities, proper handouts and similar aids.
- Employees regard occupational safety as a rule-based specialty, lacking an underlying conceptual foundation. Many also mistakenly believe that the key qualification for practicing occupational safety and health is to commit thousands of rules to memory.

The flowchart model described in this article shows the interrelationships among the process and decisions, while the text describes each process and decision. SH&E professionals may find the model useful for reviewing existing training programs, developing new programs and explaining the conceptual foundation for safety training to other managers. Readily available sources for expert advice on the various training processes are also provided.

A Model for Training

Rather than present a "how to" on safety training, this article discusses a model of the training process that can be tailored to organizational needs, that is easy to conceptualize and that is complete enough to include all major components recommended by leading training authorities. While referred to as a safety

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training model, it is intended to apply to occupational safety and health training. For flexibility, the model includes decision points and avoids specification language. For ease in conceptualizing, the model is presented as a single flowchart. Furthermore, it only includes processes likely to endure through the inevitable revisions of authoritative guidelines and standards. To ensure inclusion of all key components recommended by leading authorities, the model is compared to OSHA and ANSI guidelines.

Major Documents

The amount of literature on training is staggering. Fortunately, some recently published documents summarize the most useful wisdom for safety training. OSHA published updated guidelines for training programs in 1998 (OSHA), and NIOSH provided two documents with a more scholarly perspective. One of these NIOSH documents provides several flowchart models of training processes, with an emphasis on using the models to coordinate research on training effectiveness (NIOSH); the other provides a scholarly review and critique of training research (Cohen and Colligan).

Another important document was developed by the ANSI Z490 Committee. ASSE is secretariat for this committee, which has developed the voluntary consensus standard ANSI Z490.1-2001, Criteria for Accepted Practices in Safety, Health and Environmental Training. The standard contains criteria for developing, delivering, evaluating and managing training programs.

In developing the criteria, the Z490 Committee "combined accepted practices in the training industry with those in the safety, health and environmental industries" (ANSI Z490.1 Foreword). The intent was to develop performance-oriented guidance (Schroll). The final result is a mix of performance and specification provisions. The performance aspects are incorporated into some training program elements by using flexible language. The specification aspects come from use of the word "shall" for all components and subcomponents of every training program.

For example, ANSI Z490.1 specifies 12 information items that shall be in every certificate of completion. The performance aspect is that the training organization may decide how to arrange these items on the certificate. The extensive use of specification language means every training program must have all components in the standard, regardless of organization size or type of training (e.g., toolbox training sessions, in-class training, on-the-job training).

The flowchart model explains the process while allowing organizations more discretion to account for differences in safety training programs based on factors such as significance of the hazard at the worksite, size of the business, number of trainees, frequency of repeating the training and available training resources.

Developing the Model

Summaries of training research were reviewed (NIOSH; Cohen and Colligan). Two training programs that successfully met the needs of their sponsors and trainees were investigated as well. These investigations included discussions with developers and trainees; review of training materials; observation of training sessions; and comparison of course components with those in the OSHA guidelines. One program involved general safety training for construction laborers [Jensen(a)]; the other provided ergonomics training to nursing home workers [Jensen(b)]. Using information and insight from these sources, together with training literature, an earlier flowchart model [Jensen(c)] was modified and updated. Published guidelines (e.g., ANSI Z490.1, OSHA) were used to fine-tune terminology and descriptions in the model.

The Model

Figure 1 depicts the flowchart model. Diamond shapes that indicate decisions are labeled D1, D2, D3 and D4. Rectangles that indicate processes are numbered 1 to 7. Arrows show the order, starting at the top. The following explanations also start at the top of the model.

D1: Is Training Needed?

The model starts with a decision on whether training is needed. Common reasons for deciding that training is needed include regulatory requirements, legal liability concerns, and a desire to improve employees' abilities to recognize hazards and participate in hazard control. Of the hazard control options, hazard elimination is most desirable and may require little or no training. Other engineering controls require that employees receive some training in order to use them properly. All behavioral forms of hazard control require training so employees will know what behaviors are expected and are motivated to act accordingly. Employers implementing behavior-based safety programs need to provide training so employees can appropriately participate in the program. Samways (807-812) provides an excellent discussion of this first decision in the model. If the decision is that training is needed, the steps below D1 apply.

1) Identify Training Needs

The first process in the model is to identify training needs. This process may involve seeking input from stakeholders such as trainees, contractors and regulators. The outcomes of this process should include a goal statement, which is a longer-term statement of the reasons to conduct training.

For example, a construction company undertaking a bridge project might develop a two-part goal for fall protection training: "The goals of fall protection training are to prevent injuries and death from falling, and to comply with fall protection regulations." Some organizations extend the overall goal statement into more specific statements they may call subgoals or training objectives. Regardless of terminology and details, the process of clearly identifying training needs provides a solid foundation for the second process.

2) Develop Learning Objectives

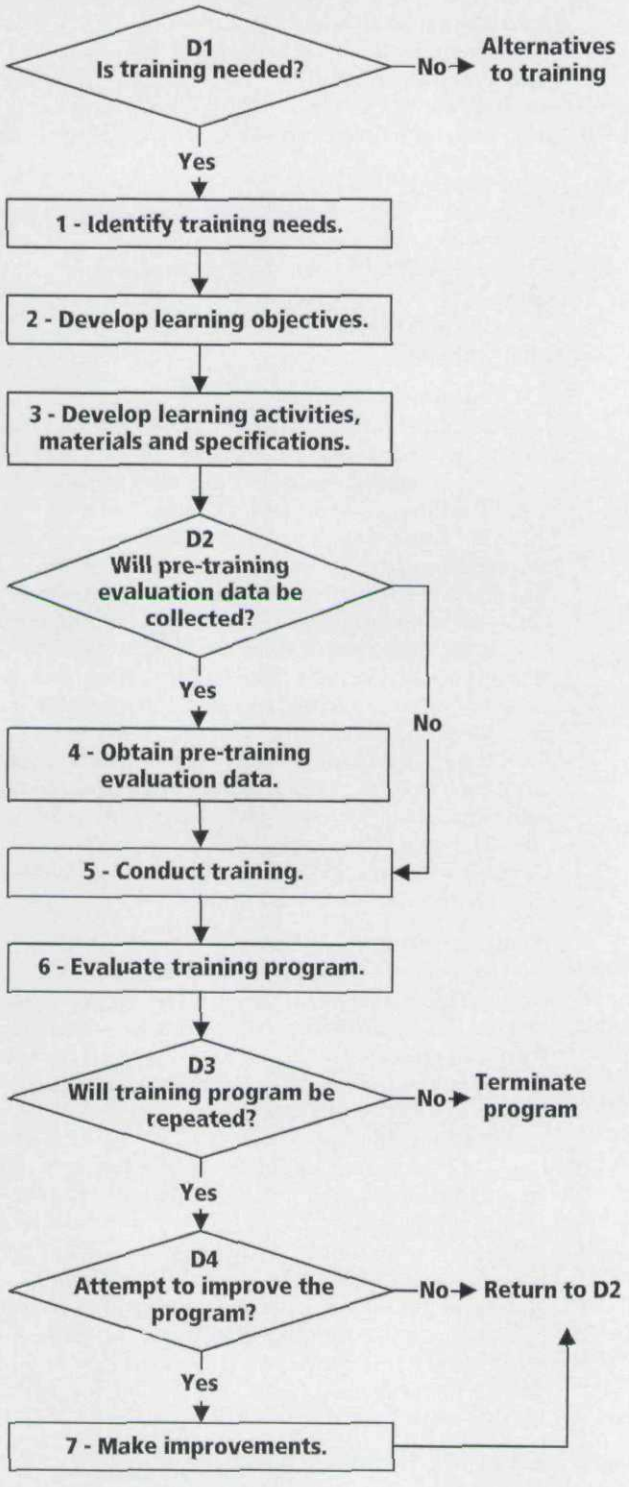
Learning objectives are statements of skills and

knowledge trainees should have mastered after completing the training. The term "learning objectives" is preferred to other terms (e.g., training objectives) because it is a reminder that the course should focus on the trainees' perspective, not the trainer's.

Learning objectives usually state the knowledge and skills to be gained, but some also include abilities, attitude, motivation and behavior. For example: "Each trainee will be able to demonstrate the skill to properly put on a fall protection harness in less than 30 seconds." Lists of learning objectives may be developed for the entire course and for each module. Annex B of ANSI Z490.1 provides guidelines for writing objectives (B.7). Useful learning objectives support the goal statement for the training program and provide the foundation for everything in processes 3 through 6.

Figure 5

Flowchart Model



3) Develop Learning Activities, Materials & Specifications

Learning activities are developed for each learning objective. These will be most effective if developed with an appreciation of how adults learn. Cantonwine provides a practical description of how adults learn, including eight principles to enhance learning (5-14). ANSI Z490.1 also describes basic instructional practices for adult learners (E5.2.4). Applying these principles and practices will often produce a course that employs diverse activities rather than continuous lecture. Diversifying classroom activities may entail keeping lectures brief, interspersing videos throughout the course, giving short quizzes, and providing hands-on experiences and group exercises.

Process 3 includes developing everything needed to conduct the course (e.g., handouts, lecture materials, tests, hands-on activities, group exercises, trainer's guide). Section 4 of ANSI Z490.1 contains many requirements to consider when designing a safety training course. For example, attendance sheets and completion certificates will be needed. Specifications or descriptions of needed facilities will be useful, particularly if any special items such as a confined space for trainees to enter for practice are needed. Room arrangements are planned as part of Process 3 as well; Cantonwine provides useful suggestions (72-76). Likewise, equipment requirements (e.g., air sampling instruments) need to be defined. The planned duration of modules, breaks and the total course should be specified as well. In addition, methods for determining achievement of learning objectives are developed during this process. These include any tests of skill and knowledge (see Cantonwine 67-71).

Communication issues to address during Process 3 include trainees' language and reading skills. This can be a challenge

because of the incredible diversity of workers in the U.S.—many of whom have limited English vocabularies and/or literacy skills. Consequently, written training material, including presentations, should aim for a reading level low enough to communicate with all target trainees. Word processing software can help the trainer determine the reading level, so training developers can set a goal for materials in terms of desired grade level.

Generally, the rated grade level of a first draft can be reduced by shortening sentences, reducing the number of sentences per paragraph and replacing three-syllable words with one- or two-syllable words. When selecting the desired level, training developers should design for all future trainees, not the average. A fifth-grade reading level is suitable for a diverse population of American workers literate in English. Workers who cannot read English at this level may need accommodations to achieve training goals. Konz and Johnson summarize numerous suggestions for optimizing communications in training material, derived from the human factors literature (596-602).

Another practical approach for addressing communication issues is to obtain assistance from the trainees' first-line supervisors. These supervisors communicate daily with the trainees and should know how to best communicate with them. All specifications mentioned should be aimed at making the learning activities meet the learning objectives.

Process 3 also includes the essential process of specifying methods for evaluating a training course. Types of evaluations have been grouped into four categories: 1) reactions of the trainees; 2) learning; 3) change in trainee behavior or performance; and 4) results or impact on the organization (Kirkpatrick). Each type requires some comment.

1) Evaluations of most occupational safety and health training include reactions of trainees. These are the common rating forms trainees complete at the end of a course. [Cantonwine (79-82) provides four examples.] This form of evaluation is suitable for determining things such as trainee impressions of the instructor, activities, facilities, time allotted to topics and perceived usefulness of the training.

2) Learning is another dimension to consider when planning the course evaluation. This type of evaluation has two levels. The more basic level—measuring proficiency—involves determining the extent to which each trainee achieved the desired skill or knowledge level. It is based on the tests of knowledge and skill administered at the end of modules and the overall course.

The more advanced level—measuring learning—involves determining the change in knowledge and skill due to the training. An effective training course will help trainees increase their knowledge or skill. To evaluate learning, one must know their knowledge and skill before the training—a step that is often overlooked.

For example, suppose an organization conducts a four-hour defensive driver training program. All trainees achieve a passing score on the end-of-course test. Without a pre-training test for comparison, however, the organization does not know whether trainees learned anything. They may all have known enough to pass the test before the training started. Thus, measuring the extent of learning attributable to a training course requires data to compare pre-training to post-training knowledge.

3) The third type of evaluation concerns behavior. This requires a system to objectively document safety-related behaviors before and after training. In one study, behavioral observations were used to evaluate a training program for forklift operators (Cohen and Jensen). Training aimed at changing safety-related behavior normally includes content aimed at affecting attitude and motivation. This part of the training may be evaluated using before and after measures of safety attitude and motivation. However, this is not as reliable as measuring on-the-job behavior because improvement in attitude and motivation does not always translate into an improved, sustainable pattern of behavior on the job.

4) For the fourth type of evaluation, several performance indicators may be used (ANSI Z490.1 E6.2.4). The most obvious and relevant are injury incidence rates. These indicators are measurable and statistical techniques are available to make the comparison (ReVelle).

However, changes in these rates are difficult to attribute to a particular training course because of the many covariates and confounding factors. For example, a training course on lockout/tagout may lead to reduced risk of injury associated with equipment maintenance, but it would take years to collect enough data to show a reduction in injury rate from the pre-training period. During that time, numerous changes may occur within the organization that might co-influence the risk, thereby preventing valid conclusions about the training causing any observed change in injury rate. Robson, et al describe some possibilities for addressing such threats to validity (19-27).

The second, third and fourth types of evaluations allow the trainer to measure the impact of the training, provided pre-training data are obtained for comparison to post-training data (Robson, et al 17-27). Process 3 includes developing the instruments and procedures for obtaining comparable pre- and post-training data. For tests of knowledge, the pre- and post-tests must involve equal difficulty. A sound way to achieve this is to develop two or four questions for each topic, then randomly assign half to the pre-test and half to the post-test. Randomization eliminates the temptation to intentionally load the pre-test with difficult questions and the post-test with easy questions. Completion of evaluation materials and all other course materials signals the end of Process 3.

D2: Will Pre-Training Evaluation Data Be Collected?

The decision to collect pre-training data is based on the types of program evaluations selected in Process 3. The thought process for this decision is part of Process 3, but the actual decision is made

The term "learning objectives" is preferred to other terms such as training objectives because it is a reminder that the course should focus on the trainees' perspective, not the trainer's.

Table 1

Comparison: OSHA Guidelines & Flowchart Model

OSHA Component	Flowchart Item
Determine whether training is needed.	D1: Is training needed?
Identify training needs.	1 - Identify training needs.
Identify goals and objectives.	2 - Develop learning objectives.
Develop learning activities.	3 - Develop learning activities, materials and specifications.
Conduct training.	5 - Conduct training.
Evaluate program effectiveness.	6 - Evaluate training program.
Improve the program.	7 - Make improvements.

each time the course is offered. For example, after the course has been conducted many times, the training sponsor may decide to save money by collecting pre- and post-training data every third time rather than every time. Therefore, the decision is a separate component of the model. According to the model, if pre-training data are to be obtained, proceed to Process 4; otherwise, go to Process 5.

4) Obtain Pre-Training Evaluation Data

Pre-training data are required to evaluate the impact of the training course. The method depends on the learning objectives and must be comparable to post-training data. A written test to measure knowledge of a topic is a common assessment. Another is a skills test, such as using a respirator or operating a crane.

A third assessment is a measure of workplace behavior. This involves systematically collecting data from behavioral observations to quantify the percentage of behaviors classified as safe or correct. An organization planning to assess the effect of the training on injury rates must obtain injury rate data for trainees before and after the training. This is a challenge due to the normal turnover of personnel and the need to base injury rates on the type of injuries the training is supposed to prevent. Usually, that means the amount of injury rate data will be insufficient for drawing statistically significant conclusions about differences between pre- and post-training performance.

5) Conduct Training

The trainer, materials and facilities are key elements of conducting effective training. The training literature contains some basic advice. For example, companies should seek qualified trainers who can communicate with trainees in their language and can earn their respect. Physical facilities, equipment and training materials should meet the specifications developed in Process 3. Trainees should be informed of their performance on tests of knowledge and skill, and sign-up sheets should be used to document attendance. Records documenting test performance and course evaluations should be saved as well. In addition, certificates should be issued to those who successfully complete the training. More extensive advice on how to conduct training effectively is available in many sources (e.g., Cantonwine; ANSI Z490.1 Annex C).

6) Evaluate Training

Process 6 involves collecting and evaluating post-training data. For Kirkpatrick's first type of evaluation, this involves having trainees complete a course rating form, then reviewing those ratings and providing feedback to the instructor. For the second type of evaluation, trainee performance is compared to learning objectives and pre-training performance.

For the third and fourth types of evaluation, post-training data are collected and compared to pre-training data and performance objectives. For most training programs, the evaluation process is completed before moving to the next decision and the model reflects this order. However, for Kirpatrick's third and fourth types of evaluation, if post-training data collection is extended, the next two decisions might be made before completing the evaluation.

D3: Will the Training Program Be Repeated?

Generally, once a safety training program has been developed, it will be conducted periodically. The flowchart model recognizes that an organization's needs may change and a particular program may be terminated. For example, the firm might decide to outsource the activity addressed by the training. If the training will be repeated, proceed to D4.

D4: Attempt to Improve the Program?

A training program is evaluated to obtain information about its quality and performance. To make this process effective, trainers must be open-minded, thick-skinned and not defensive. If the evaluation indicates a need to improve the program, proceed to Process 7. If not, the program is ready to conduct again, starting with a decision about collecting pre-training data. The flowchart model shows these alternative pathways.

7) Make Improvements

Any aspect of a training course may be improved, including training materials, facilities, instructor performance, time allocations to topics and evaluation tools. Many organizations conduct a new course once as a trial or pilot test to identify weaknesses typical of first-time efforts. A philosophy of continuous improvement should help trainers make incremental improvements to each program. Improvements should be documented, as this can prove useful if the organization participates in vol-

untary quality recognition programs or OSHA's Voluntary Protection Programs.

The processes and decisions described are based on safety training literature and in-depth investigations of two successful programs [Jensen(a); (b)]. To assess the inclusiveness of the model, it is now compared to OSHA guidelines and ANSI recommendations.

Comparison to OSHA Guidelines

Training guidelines from OSHA involve the list of components listed in the left column of Table 1; the right column has the corresponding item in the flowchart model. As this shows, the flowchart model contains all OSHA components. Missing from the OSHA list is the explicit decision (D2) regarding collection of pre-training data and the actual process of collecting those data (Process 4).

Table 2

Comparison: ANSI Z490.1-2001 & Flowchart Model

ANSI Component	Flowchart Item
Training program administration and management.	Not included.
Needs assessment.	1 - Identify training needs.
Learning objectives and prerequisites.	2 - Develop learning objectives.
Course design.	3 - Develop learning activities, materials and specifications.
Specify site, schedule, trainer qualifications, trainer-to-trainee ratio and evaluation strategy.	3 - Same as above.
Establish criteria for completing course.	3 - Same as above.
Training delivery.	5 - Conduct training.
Evaluate training using appropriate tools.	6 - Evaluate training program.
Use evaluation results to improve training.	7 - Make improvements.
Documentation and recordkeeping.	Part of processes 3, 5, 6 and 7.

Comparison to ANSI Z490.1

Training guidelines found in ANSI Z490.1 involve the list of components in the left column of Table 2; the right column has the corresponding item in the flowchart model. Note the three differences. The ANSI standard contains one component not in the flowchart model—overall training program administration and management. The standard addresses management systems for SH&E training. It includes aspects such as assigning responsibility and accountability, providing appropriate resources to support each course and periodically evaluating the training organization.

These important aspects may be appropriately characterized as horizontal components, applicable to all courses conducted by a training organization. Management systems are useful for all organizations, but especially for larger organizations that have a training department separate from the safety and health department. Interdepartmental friction can arise if responsibilities and resources are unclear. The flowchart model incorporates only the vertical components applicable to specific training courses.

The second difference is that the ANSI list, like the OSHA list, does not include the explicit decision to collect pre-training data (D2) or the process to do so (Process 4). The third difference is the treatment of documentation and recordkeeping. ANSI Z490.1 characterizes documentation and recordkeeping as a separate element in the overall training program management system. The flowchart model treats these activities as subparts of processes 3, 5, 6 and 7.

As noted, the flowchart model was developed by reviewing summaries of training literature and examining two successful training programs, while OSHA guidelines and ANSI Z490.1 were used to fine-tune the model. Comparison of the flowchart model to OSHA and ANSI recommendations shows that the model includes the same components except for ANSI's overall training program management element. The flowchart model is the only one that makes explicit the decision to collect pre-training data in order to determine the impact of the training course.

Who Could Use a Model?

Who might benefit from using such a model? It may prove useful to people with five different perspectives on safety training.

1) SH&E professionals generally have considerable expertise on the subject matter of the training. This expertise is an essential element of effective training, but it is not sufficient to maximize benefits from the resources invested in the training. The model may provide a tool for learning about training processes without spending countless hours reading training literature. The model may also provide a new perspective on the contribution of each process to the overall quality of a safety training program. Higher quality should lead to improved learning and reduced risk for trainees. In addition, when SH&E professionals encounter articles on training, an understanding of the model will help them put the material into a familiar, easily remembered context.

2) College students pursuing degrees in occupa-

SH&E professionals may use the flowchart model to review current safety training programs, develop new programs and explain the conceptual foundation for safety training to other managers.

tional safety and health may view training differently than practitioners. Students often find themselves trying to learn the rules and regulations for a wide range of specific programs. These regulations vary significantly in depth and specificity. Attempting to learn all these nonuniform regulations for training can be overwhelming. A far more efficient method is to learn one sound training model, and use this as a framework for understanding specific SH&E training requirements.

3) Financial managers may find value in the model as well. They may more readily allocate resources to SH&E if confident that the training will be properly developed, conducted and evaluated. The model may also be used to educate these managers on the processes and broader conceptual foundation for safety training.

4) Large employers that outsource training may also use the model. The prime/host employer needs to describe requirements in order to obtain proposals suitable for comparison. One approach is to incorporate by reference a document containing requirements (e.g., OSHA guidelines, ANSI Z490.1). This model is another option. An organization could organize its requirements using the model, then add detailed requirements using company policies and other sources.

5) Litigants in legal proceedings where training is an issue can also benefit from this model. The adequacy of an SH&E training program becomes an issue in two types of cases:

a) Defense to OSHA citations known as the unpreventable employee misconduct defense (OSHA 2). Basically, the employer seeks to avoid responsibility for an employee's misconduct by showing the employee was adequately trained and supervised, but acted badly on the particular occasion for which the citation was issued.

b) Product liability suit in which an injured employee sues a manufacturer alleging that a defect in its equipment or materials caused the injury/disease. The manufacturer joins the employer into the suit alleging that the real cause of the injury/disease was inadequate training.

In both types of litigation, the employer has the burden of producing evidence that its training program was adequate. Attorneys for both sides will seek standards and guidelines to serve as yardsticks for training adequacy. Each side will attempt to choose the standard/guideline most favorable to its case. In such cases, an employer will be better positioned to meet its burden of proof if it has proactively adopted a policy of conforming to a flexible standard for training programs than it would be with no policy or with a policy of conforming to a more rigid standard.

Conclusion

By incorporating decisions with the processes, the flexible flowchart model allows a company to tailor a program to match training needs. It also provides a graphical description of the order and interrelationships among program components and decisions. This should make forming a mental model easier than reading a long text description. Such a model should be especially helpful for college students so they can more easily appreciate the training requirements found in various regulations, standards and guidelines. In addition, the model contains an explicit decision point regarding collection of pre-training data that are needed to truly measure the impact of a training program. ■

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Acknowledgments

The author of this paper was partially supported by training grant No. T03/CCT822949 from CDC/NIOSH. The contents are solely the responsibility of the author and do not necessarily represent the official views of NIOSH.

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