



# *Technical Training*

Qualification Standard  
*Reference Guide*  
December 2009

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<b>Acronyms</b>	
ADDIE	analyze, design, develop, implement, and evaluate
ANS	American Nuclear Society
ANSI	American National Standards Institute
ASTD	American Society for Training and Development
CD	critical decision
CFO	Chief Financial Officer
CPM	critical-path method
DEAR	Department of Energy Acquisition Regulation
DIF	difficulty, importance, and frequency
DOE	U.S. Department of Energy
FAR	Federal Acquisition Regulation
FAQS	functional area qualification standard
FTCP	Federal Technical Capability Program
GET	general employee training
HCM	Human Capital Management
HQ	Headquarters
HR	human resource
ICE	independent cost estimate
ISM	integrated safety management
ISMS	integrated safety management system
KD	key decision
KSA	knowledge, skill, and ability
M&O	management and operating
NEPA	National Environmental Protection Agency
NNSA	National Nuclear Security Administration
OJT	on-the-job training
OSHA	Occupational Safety and Health Administration
QA	quality assurance
QAP	quality assurance program
RFP	request for proposal
SAE	Secretarial Acquisition Executive
SAT	systematic approach to training
SME	subject matter expert
TES	training/evaluation standard
WBS	work breakdown structure

## PURPOSE

The purpose of this reference guide is to provide a document that contains the information required for a Department of Energy (DOE)/National Nuclear Security Administration (NNSA) technical employee to successfully complete the Technical Training Functional Area Qualification Standard (FAQS). Information essential to meeting the qualification requirements is provided; however, some competency statements require extensive knowledge or skill development. Reproducing all the required information for those statements in this document is not practical. In those instances, references are included to guide the candidate to additional resources.

## SCOPE

This reference guide addresses the competency statements in the February 2004 edition of DOE-STD-1179-2004, *Technical Training Functional Area Qualification Standard*. The qualification standard contains 17 competency statements.

Please direct your questions or comments related to this document to the NNSA Learning and Career Development Department.

## PREFACE

Competency statements and supporting knowledge and/or skill statements from the qualification standard are shown in contrasting bold type, while the corresponding information associated with each statement is provided below it.

A comprehensive list of acronyms and abbreviations is found at the beginning of this document. It is recommended that the candidate review the list prior to proceeding with the competencies, as the acronyms and abbreviations may not be further defined within the text unless special emphasis is required.

The competencies and supporting knowledge, skill, and ability (KSA) statements are taken directly from the FAQS. Most corrections to spelling, punctuation, and grammar have been made without remark, and all document-related titles, which variously appear in roman or italic type or set within quotation marks, have been changed to plain text, also mostly without remark. Capitalized terms are found as such in the qualification standard and remain so in this reference guide. When they are needed for clarification, explanations are enclosed in brackets.

Every effort has been made to provide the most current information and references available as of December 2009. However, the candidate is advised to verify the applicability of the information provided. It is recognized that some personnel may oversee facilities that utilize predecessor documents to those identified. In those cases, such documents should be included in local qualification standards via the Technical Qualification Program.

In the cases where information about an FAQS topic in a competency or KSA statement is not available in the newest edition of a standard (consensus or industry), an older version is referenced. These references are noted in the text and in the bibliography.

Only significant corrections to errors in the technical content of the discussion text source material are identified. Editorial changes that do not affect the technical content (e.g., grammatical or spelling corrections, and changes to style) appear without remark.

## TECHNICAL COMPETENCIES

1. **Technical training personnel shall demonstrate an expert level of knowledge and ability to implement the systematic approach to training model. This includes the ability to:**
  - **Conduct a job or task analysis or needs assessment, analyze the data, and provide recommendations based on results;**
  - **Design a training course or program to satisfy training requirements;**
  - **Develop a training course and supporting materials;**
  - **Implement a training course or program; and**
  - **Evaluate a training course or program as part of the systematic approach to training process or to assess return on investment.**
- a. **State the five steps of the SAT process and produce a basic sketch showing the relationship between the steps.**

The following is taken from Instructional Design: Using the ADDIE Model.

The acronym ADDIE stands for analyze, design, develop, implement, and evaluate. It is a systematic approach to training (SAT) model that has withstood the test of time and use. It is simply a device to help us think through a course's design. Though the model appears linear, it does not have to be followed rigidly or in a linear approach, especially if you already have course materials developed. The table below gives an abbreviated overview of some of the components of ADDIE.

Analyze	Design	Develop	Implement	Evaluate
Pre-planning; thinking about the course	Design your course on paper	Develop course materials and assemble the course	Begin teaching	Look at the course outcomes with a critical eye
<ul style="list-style-type: none"><li>• Design of course</li><li>• Audience</li><li>• Goal</li><li>• Objectives</li><li>• Identify content</li><li>• Identify environment and delivery</li><li>• Instructional Strategies</li><li>• Assessment Strategies</li><li>• Formative Evaluation</li><li>• Constraints</li></ul>	<ul style="list-style-type: none"><li>• Name the learning units of instruction</li><li>• Identify content and strategies for an individual unit of instruction</li><li>• Write instructions for the learning unit</li><li>• Name the menu items for a learning module</li></ul>	<ul style="list-style-type: none"><li>• Based on design phase</li><li>• Build content, assignments, assessments</li><li>• Build course structure</li><li>• Upload content</li></ul>	<ul style="list-style-type: none"><li>• Overview of course</li><li>• Expectations</li><li>• Initiate instruction</li><li>• Interaction</li><li>• Ask for feedback early on (formative evaluation)</li></ul>	<ul style="list-style-type: none"><li>• Did the students achieve expected learning outcomes?</li><li>• What have you learned?</li><li>• How can you make the course better?</li></ul>

*Source:* Instructional Design: Using the ADDIE Model

**Figure 1.** Using the ADDIE Model



- b. Referring to DOE-HDBK-1078-94, Training Program Handbook: A Systematic Approach to Training, describe in detail the activities that occur in each of the five steps of the SAT process, and list the products that may result from each of the steps.**

The following is taken from DOE-HDBK-1078-94.

#### *Analysis*

This section addresses three methods of identifying training/performance requirements: needs analysis, job analysis, and task analysis. The major outputs of the analysis phases are a task list for each position, and a task-to-training matrix.

The task-to-training matrix identifies the training disposition of the tasks identified in the task list and lists the existing materials that support task performance. Participation of subject matter experts (SMEs) and facility personnel is emphasized throughout the processes.

#### *Design*

The design phase uses the information collected during the analysis phase to provide a “blueprint” for developing training programs based on the SAT model. This step in the process addresses methods for writing learning objectives, setting training standards, designing tests, and preparing training plans. The major outputs of the design phase are learning objectives and test items. For existing programs, contractors are encouraged to determine if their learning objectives are appropriate, cover all required content, and include appropriate criteria and conditions.

#### *Development*

Development incorporates the results of the design activities. The major outputs of the development phase are the completed lesson plans and training aids.

#### *Implementation*

Implementation encompasses taking the results of the development phase into the training setting and conducting the training. The major output of the implementation phase is trained personnel.

#### *Evaluation*

Evaluation consists of a periodic review of the training materials and methods of soliciting feedback from former trainees and their supervisors on the effectiveness of training. The major outputs of evaluation are the decisions made to improve the training program during all phases.

- c. Describe the purpose and process for conducting a needs analysis, job analysis, and task analysis.**

The following descriptions are taken from DOE-HDBK-1078-94.

#### *Needs Analysis*

A needs analysis can identify solutions to job performance discrepancies. Substandard performance may be related to faulty equipment, inadequate procedures, attitude of the

workforce, etc. Prior to developing new courses or modifying existing training programs, a needs analysis should be conducted to determine that training is the appropriate solution.

### *Job Analysis*

A job analysis is conducted to develop a detailed list of duty areas and tasks for a specific job or position. It can also supply information to develop a job/position description, if desired. Job analyses also allow comparison of existing training programs to established requirements and identify deficiencies in the adequacy of program content. For existing programs, the job analysis provides reasonable assurance that all tasks essential to safe and efficient operation are addressed by the training program. It also identifies parts of the training program that are unnecessary, thus resulting in a more effective training program and more efficient utilization of resources. For facilities/sites/offices developing new programs, the job analysis provides the information necessary to identify tasks associated with the job. Training design and development activities can then be based on actual needs, as opposed to perceived needs.

### *Task Analysis*

As training is designed and developed for the tasks selected for training, each task should be analyzed to determine the KSAs required for satisfactory accomplishment of the task.

#### **d. Describe the functional relationship between tasks, learning objectives, training materials, and trainee evaluations.**

The following is taken from DOE-HDBK-1078-94.

Terminal learning objectives are learning objectives that clearly state the measurable performance the trainee will be able to demonstrate at the conclusion of training, including conditions and standards of performance. They are translated directly from the task statement, and provide the framework for the development of training/evaluation standards, enabling objectives, and lesson plans. Care must be taken when developing and writing learning objectives. Trainees must clearly understand them, or they are of limited use. Related terminal objectives must be written for each task statement before any other design work is begun.

Enabling objectives are learning objectives that support the terminal objective. They include the critical components of performance, conditions, and standards. Enabling objectives should be written directly from the KSAs required for element performance.

#### **e. State and describe the components of an internal training program evaluation process to assess the effectiveness of training.**

The following is taken from DOE-HDBK-1070-94.

Training program evaluations should be conducted through observation of the overall program and they should answer the question: “Does the training program meet the objectives and criteria?” The following resources should be used when conducting training program evaluations:

- facility policies, procedures, program descriptions, and records;
- training materials, such as lesson plans, guides, student handouts, and tests; and

- cognizant facility personnel.

Evaluations should be conducted at the facility, at the training center, and at other locations where training activities occur. Evaluations should center around three major activities to determine the extent to which training programs are meeting the objectives and criteria. These activities include observation of training, personnel interviews, and document reviews.

- f. Based on an analyzed training need, design, develop, implement, and evaluate a course of instruction.**
- g. Evaluate how well a given training organization has implemented the five steps of the SAT process.**

Elements f and g are performance-based KSAs. The Qualifying Official will evaluate their completion.

**2. Technical training personnel shall demonstrate a working level knowledge of DOE training organizations, strategic initiatives, roles and responsibilities, and training administration and infrastructure.**

- a. Describe the current initiatives of the DOE Office of Training and Human Resources Development, and explain how they apply to the field and headquarters training offices.**

**[Note: the Office of Training and Human Resources Development has been superseded by the Office of Human Capital Management.]**

The following is taken from the Office of the Chief Human Capital Officer, About Human Capital Management.

The Office of the Chief Human Capital Officer provides leadership to the DOE on the impact and use of policies, proposals, programs, and partnership agreements/relationships related to all aspects of Human Capital Management (HCM). HCM uses an integrated approach that links human resources, training and development, and diversity in developing, deploying, and assessing a full range of short- and long-term HCM solutions, policies, and programs. We proactively seek solutions and approaches to serve the needs of the Department and advance and support the DOE mission by creating and implementing solutions that address workforce issues in the areas of recruiting, hiring, motivating, succession planning, competency development, training and learning, retention, and diversity.

The vision of the Office of the Chief Human Capital Officer is to accomplish mission objectives through collaborative partnerships emphasizing quality, responsive, innovative HCM services and proactive problem identification and resolution to attract, develop, motivate, and retain a high performing workforce.

Functions include the following:

- Oversee and coordinate the Office of the Chief Human Capital Officer's commitments to the DOE strategic plan and other DOE-wide performance-based

- initiatives, including the Department's annual performance plan as well as presidential and other key human capital management initiatives.
- Serve as the Department's principal human capital management expert and advisor and implement the rules and regulations of the President and the Office of Personnel Management and the laws of the DOE.
  - Serve as human resources advisor on matters relating to competitive sourcing.
  - Serve as or designate the Executive Secretary for the Federal Technical Capability Program (FTCP) Panel as the Office of Human Capital Management Agent.
  - Serve as the central focus for cutting-edge human capital management research and initiatives related to HCM competency development, change management, HCM career development and management, communications, marketing, and benchmarking and liaisons with public/private/non-profits/academia in these areas.
  - Assess workforce characteristics and future needs based on the DOE's mission and strategic plan.
  - Oversee all administrative and business functions for the organization, including internal measuring/tracking.
  - Take responsibility for developing and advocating a culture of continuous learning and provide overall coordination and delivery of enterprise-wide leadership, learning, and development services.

**b. Describe the Federal Technical Capability Program (as listed in DOE M 426.1-1, Federal Technical Capability Manual) and its application to the field and headquarters training offices.**

**[Note: DOE M 426.1-1 has been superseded by DOE M 426.1-1A.]**

The following is taken from DOE M 426.1-1A.

The DOE is committed to ensuring that employees are trained and technically capable of performing their duties. In pursuit of this objective, the Secretary of Energy issued DOE P 426.1, *Federal Technical Capability Policy for Defense Nuclear Facilities*, to institutionalize the FTCP. This program specifically applies to those offices and organizations performing functions related to the safe operation of defense nuclear facilities, including the NNSA. It applies to all aspects of recruitment, deployment, development, and retention of Federal employees in these organizations.

The Secretary of Energy has delegated authority for implementing and maintaining the FTCP to the Deputy Secretary of Energy. Other DOE offices and organizations must ensure their Federal employees are appropriately trained and technically capable when carrying out their responsibilities. When appropriate, these offices and organizations should implement applicable portions of the FTCP.

The objective of the FTCP is to recruit, deploy, develop, and retain Federal employees with the necessary technical capabilities to safely accomplish the Department's missions and responsibilities. The Department has identified guiding principles to accomplish that objective and identified four general functions of the FTCP. The Department's Integrated Safety Management (ISM) Guiding Principles state that

- Federal personnel possess the experience, knowledge, skills, and abilities that are necessary to discharge their safety responsibilities;
- line managers are accountable and have the responsibility, authority, and flexibility to achieve and maintain technical excellence;
- supporting organizations recognize line managers as customers and effectively support them in achieving and maintaining technical capabilities;
- an integrated corporate approach is required to ensure that necessary technical capabilities and resources are available to meet the overall needs of the Department's defense nuclear facility missions.

**c. State and discuss some of the attributes of an efficient and effective technical training organization at a defense nuclear facility.**

The following is taken from DOE, *Supplemental Guidance for Technical Training Organizational Infrastructure, Responsibilities, and Personnel Qualification*.

Organization of training is a strategic issue because it affects so many areas. Organization affects the linkage and communications channels between the training organization and its customers. The ability of the training organization to recruit and support specialized expertise in instructional design and other training and education specialties are affected by the organizational structure. Structure also affects the ability to establish and manage the training processes, the efficient and effective teaming of SMEs with instructional specialists, and the ability to measure and control results.

There is no single training organization structure that is best for all situations. In fact, as conditions evolve in a company, the training structure should evolve to fit the new conditions.

Part of the management and operating (M&O) contractors' training strategy should be the periodic review of the effectiveness of the current organizational structure and planned changes as conditions evolve within the organization and/or facility.

The old architects' maxim "form follows function" also applies to the design of training organizations. The organization's form should be determined by its function. The structural design should be driven by the company's strategic vision and goals and by the amount of work to be performed and resources to be organized to accomplish the work. Examples of questions that should be addressed when establishing a training organization structure include the following:

- What training responsibilities will be delegated to the training organization(s), and what responsibilities will be retained by line managers?
- To what degree is it appropriate to centralize certain training responsibilities?
- How will the organization support the specialized expertise needed to achieve strategic training goals such as implementing alternative delivery media and addressing the training requirements for emerging and changing technologies?
- How will the organization, structure, and management of the training functions mesh with the overall philosophy of the contractor and the parent organization?
- How will the organization manage control of training results and training costs?

- How will the organization facilitate clear communication between the training unit(s) and their user groups?
- How can expensive duplication of the development and implementation of training materials be effectively avoided?
- How can the training function be structured to get the greatest return for the training investment?
- How much of the training program will be based on generic courses and how much will be based on custom-designed courses?
- What structure will best ensure responsiveness to changing user needs?

Following are guidelines to consider when organizing the training function:

- Formulate and implement a training policy to support the needs of operations. The training policy should be based on a broad vision of employees' training, education, development, and qualification needs, and the skills and experience required to meet those needs. Other policy considerations include, but are not limited to: management's use of training to prepare professionals to meet the challenges of cultural, managerial, organizational, and technological changes; using training to acquire and reinforce skills in safety, environmental concerns, and production costs; and sharing responsibilities and tasks between the corporate structure and the individual sites and facilities.
- Create a position for a senior-level training manager. Training organizations should have a training manager who has responsibilities and authorities broad enough to provide leadership, to oversee training across the entire organization, and to represent the training area with senior management. The position should be at the highest management level possible, with proper consideration given to the size of the overall organization.
- Determine the size of the training organization. Training organizations that try to be all things to all people become unwieldy, bureaucratic, and unresponsive to their users. Even in cases where training is centralized, there are training functions that are better suited to other organizations. Do not try to force all training functions into one large training organization. Training organizations should, however, be large enough to support the specialized expertise needed by smaller units. Small units located around the site without specialized support seldom achieve the cohesiveness necessary to support their individual needs. Specialized expertise in functions such as the following may be required to enable individual facilities to accomplish their mission:
  - Performance analysis and training needs analysis
  - Curriculum design and instructional design and development
  - Testing, measurement, and evaluation
  - Alternative delivery media such as computer-based training
  - Video and audio scripting and production
- Centralize the development of common instructional materials. There is no need for each organization (e.g., operations, maintenance, environmental restoration) to develop its own basic courseware when the instruction has a common core, such as Hazardous Waste Operations and Emergency Response, Radiation Worker, or Occupational Safety and Health Administration (OSHA) training. It is more efficient

- and economical to modify core materials to fit the needs of the affected organization than it is to repeatedly conduct the initial development efforts.
- Provide leadership in the areas of instructional methodology, technology, and procedures. Organizations with multiple training organizations, each espousing different methods, standards, and procedures, have great difficulty sharing curriculum, course materials, and administrative systems. Training organizations should consider having one group or sub-unit charged with instructional methodology and consulting within the organization.
  - Follow a systematic project plan and process to develop instructional materials. The planning and use of training resources is a critical element in the success of any training organization. Training material content, level of detail, testing, and evaluation should be consistent across the facility and should be systematically developed. Interrupting development of one course to teach another course can adversely affect development projects, particularly if the people have heavy teaching loads. Training workloads should be adjusted to provide the support needed for the development or revision of courses. Instructors who will teach the courses should be used as technical advisors to the development team to ensure accuracy and relevance, and to accommodate changing priorities.
  - Use strategic planning to prepare for the future. Strategic, long-term planning should be an integral part of the training function. Using training as a quick-fix in correcting problems encountered as a result of poor up-front planning should be avoided.

**d. State and discuss the advantages and the disadvantages of centralized and decentralized training organizations.**

The following is taken from DOE, *Supplemental Guidance for Technical Training Organizational Infrastructure, Responsibilities, and Personnel Qualification*.

Whether to centralize, decentralize, or integrate the training functions is a major consideration when designing the structure of an organization. American business, industry in general, and DOE M&O contractors specifically, have struggled with this question in recent decades. Industry and contractors continue to search for the right mix of overall direction and local delivery of training.

*Centralization of Training*

Technical training systems are considered centralized when the function is coordinated and/or controlled primarily from a single organization within the company. In training organizations with personnel who need strong, clear direction, or where individual ownership of the job is minimal, managers find greater quality control with the training function centralized. Centralized training administration is also valuable in circumstances where conformity to standards, uniformity in application, and formal documentation is essential. The following strengths and weaknesses come from the experiences of many corporations and are documented in recent literature on the subject. The relative impact of each of the strengths and weaknesses are obviously a function of the implementing organization.

**Strengths**

- Consistency in training material and content

- Consistency in the articulation of organizational values
- Economy of scale
- Improved consistency in instructional design and presentation methods
- A common structure for sharing and exchanging information

#### Weaknesses

- Loss of local autonomy, control, and ownership of training programs
- Loss of customization of training content
- Potential for decisions to be made at the least effective decision-making level
- Difficulties in changing and adapting to new needs
- Potential for inhibiting initiative and personal responsibility

Centralized control over technical training may not be appropriate for all organizations. In some cases, strong centralization of the training function has led to an over-emphasis on the form and structure of training design and development, which did not add sufficient value and increased the cost of training unnecessarily. Over-centralization of training has also resulted in reduction of facility line management involvement with formulating and conducting training programs and with follow-up actions. In some cases, training has been designed around guidelines, typical scenarios, and catalogs rather than around the changing needs of individuals or technologies. Sacrificing training content and needs (function) to administration and structure (form) and losing line management ownership and participation in training are pitfalls of centralization that must be guarded against.

#### *Decentralization of Training*

Technical training systems are considered decentralized when control over training functions is delegated to a local organizational level and there is no common point of coordination among separate facilities or training entities within the larger organization. Decentralized training organizations are autonomous organizations within divisions of the company that organize and implement their own programs and conduct their own evaluations. A decentralized structure generally works well in an organization which produces a diverse array of products or uses several different processing methods or levels of technology. A decentralized structure places technical training closer to line operations and allows training to develop closer relationships with the operations personnel, from whom technical trainers must draw their expertise. The following strengths and weaknesses have been identified through research and experience. As with anything, these can be either minimized or exacerbated by the implementing organization.

#### Strengths

- Immediacy and credibility of the training programs
- Greater ownership of training program content and products
- Greater line management involvement
- Training fits cultural and geographic diversity
- Decision-making is closer to the customer
- Local budget control

#### Weaknesses

- Potential for inconsistencies in training program content and materials



- Difficult to share and exchange information and training programs due to diversity
- Demanding on human and material resources
- Potential for inconsistent (or lower) quality of training and training materials

A decentralized training structure is more susceptible to the influence of local management and can be more difficult to control and monitor. Research shows that a decentralized structure is generally inefficient in organizations where most products or processes are similar within a division or department or among several facilities. It is also more difficult to link technical training to the higher-level mission and strategies of the organization and for corporate management to provide coordination. Decentralization may lead to duplication, and care must be taken to coordinate course development to utilize all developed courses across the organization.

**e. Explain the purpose of a training policy and procedure manual and discuss the typical policies and procedures that may be found in this manual.**

The following is taken from DOE-HDBK-1078-94.

The training management manual should formalize facility policies and procedures for training. Examples of sections that should be included in the manual follow:

- Introduction and Organization
  - Purpose and scope of the manual
  - Manual compliance requirements
  - Training program purpose and goals
  - Organizational relationships and reporting structure
- Qualification and Training Program Descriptions
  - Overview of qualification and training programs
  - New employee orientation or indoctrination
  - Visitor indoctrination
  - Subcontractor indoctrination and training
  - Descriptions of all training programs (individually or by groups)
  - Instructor training and qualification
  - Continuing training
  - Proficiency requirements
  - Requalification (periodic, following disqualification, lapsed qualification, etc.)
- Training Program Material Development and Administration
  - Training/evaluation standards
  - Checklists or qualification cards
  - Lesson plans, on-the-job-training (OJT) guides, lab guides, etc.
  - Training aids and reference material
- Training Program Standards and Policies
  - Academic standards
  - Examinations
  - OJT (conduct and evaluation)
  - Lectures, seminars, training exercises, etc.
  - Drills

- Signature requirements
- Student conduct and controls
- Disqualification procedures and policies
- Exceptions, extensions, and waivers
- Administration
  - Training and qualification records
  - Selection and qualification of instructors
  - Training program development/change requests
  - Audits (internal and external)
  - Evaluating training program effectiveness
  - Control of subcontracted training

**f. Describe the roles and responsibilities of line management, the training organization, and the employee as related to training and qualification.**

The following is taken from DOE-HDBK-1114-98.

Line managers are responsible for the training, qualification, and performance of operating organization personnel to support safe and reliable operations. Line managers should verify that training meets the needs of their organizations to help ensure the safe and reliable operation of their facilities. This is accomplished by a variety of methods including observation of training and qualification activities, observation of personnel performance on the job, and interviews that can identify knowledge or skill weaknesses. Line managers should provide results of their training reviews as feedback to training department managers in order to improve the training program.

Performance standards established by line managers should be presented, discussed, and reinforced during initial and continuing training. Understanding of these standards should be verified during employee training evaluation and the qualification process. Line manager standards of performance, such as policies, procedures, and standing orders, should be written. Industry experience has shown that standards need a thorough explanation so that expectations are clear. Many line managers have found it effective to discuss and explain their standards of performance during training sessions because they can focus attention with minimal interruptions. For example, an operations manager can reinforce the expectations of team communications following an exercise by using examples from that exercise. Similarly, a maintenance manager can reinforce expectations of adherence to procedures during hands-on pump alignment training. Periodic review and reemphasis of performance standards and expectations are helpful during training, particularly if done by managers, when expectations are not being fully met.

The importance of conducting work activities according to approved practices and procedures should be emphasized continuously, especially during training. Additionally, the reasons behind work standards should be explained. This information is best explained by line managers and supervisors. Personnel who understand the reasons for a standard are better able to meet their management's expectations.

Line managers should monitor and assess personnel performance to determine how well established standards are being met. Results of the assessments can be used to determine training effectiveness and to revise training programs or develop other corrective actions.

The roles and responsibilities of the training organization are to

- manage assigned training functions, including, but not limited to
  - training compliance with applicable laws, regulations, policies, requirements, and provisions of training agreements;
  - training policy and program development;
  - training program cooperation and liaison with other DOE elements; and
  - training program evaluation and self-assessment.
- approve and coordinate additional approvals, authorizations, and/or concurrences for training for any Federal employee if officials with responsibility for that employee's training are not located at that duty station.

**g. Explain how to use facilities, equipment and materials in an efficient manner to implement the training process.**

The following is taken from DOE/NE-0102T.

To ensure that facilities and resources are available to support training activities, the training manual should address physical facilities, equipment, and reference materials.

Physical facilities and equipment include the following:

- Classroom facilities
- Laboratories and workshop facilities
- Simulators
- Audiovisual aids and equipment
- Tools and equipment
- Office space and furnishings

Technical reference material should cover topics at a level appropriate for the program, instructor, and trainee; should be applicable to facility systems and equipment; and should be current with facility modifications.

**h. Describe the purpose and attributes of a technical training resource library.**

The following is taken from DOE-HDBK-1114-98.

Improved facility performance due to the training organization is often the basis for the allocation of facility resources to training. This provides future impetus for the training organization to consistently provide high-quality training.

The training environment should promote learning and support a variety of instructional techniques. This environment should include facilities such as classrooms, simulators and laboratories (if applicable), and mock-ups designed and maintained to meet training program requirements. Training support services, such as reference libraries and quiet study areas, should be available and maintained to meet personnel and instructor needs. Training staff

facilities should encourage development of high-quality instructional material, instructor preparation, and personnel counseling.

Training settings, such as simulators and laboratories, should reflect actual facility equipment and the working environment as closely as possible, and should be reviewed and updated continually. Noted differences should be explained to personnel before training begins.

Instructional media equipment and support should be available and maintained to allow for a variety of instructional methods for achieving learning objectives. Effective information systems, including accurate databases, should be used to manage training activities.

The training organization should be staffed with personnel who are technically qualified, respected by facility personnel, and who are trained instructors. If subcontract personnel are used, they should have the knowledge and skills necessary for assigned responsibilities.

**i. Describe the process necessary to share training materials and resources among the federal and contractor training organizations.**

The following is taken from DOE, Calculating Cost Savings from Sharing Training Materials.

Technical fundamentals are an important part of a comprehensive training program for numerous positions in operating organizations at Department-owned nuclear facilities. The Department has developed fundamentals training materials for several key areas that address the theory necessary to support technical operations in many facilities. This material is useful in initial and continuing training programs, and has been used by many of the DOE contractor organizations.

Because the Department developed the material and it is available without cost to DOE and DOE contractors, recipients realize a significant cost savings when the material is used. The material is generically applicable to many functional job positions and requires little or no revision by contractors to meet their needs in this area. Use of the material precludes the necessity for costly internal development for contractors with employees that require fundamentals training.

Fundamentals training material has been developed and is available to DOE and contractor organizations in the following topical areas:

- Mathematics
- Classical Physics
- Nuclear Physics and Reactor Theory
- Materials Science
- Electrical Science
- Mechanical Science
- Chemistry
- Engineering Symbolology, Prints, and Drawings
- Heat Transfer, Fluid Flow, and Thermodynamics
- Instrumentation and Controls

Calculation of the savings associated with provision of fundamentals training materials involves some estimation. Because the material that is available has been developed to meet a need or requirement, the initial cost of development need not be recovered when determining savings. Each time a DOE or contractor organization adopts available material, a cost savings is realized because the material did not have to be developed internally. This savings will be significant in many instances because the expertise is often not available locally for much of the material and outside vendors would have to be used if the material were developed internally.

- j. Participate on a local headquarters-sponsored fact-finding team, working group, or related training and human resources initiative that assesses impact, supports, or implements a DOE human resources initiative.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion.

- k. Using DOE-HDBK-1001-96, Guide to Good Practices for Training and Qualification of Instructors, describe the qualification, requalification and monitoring of trainers, including OJT instructors, needed to ensure the effectiveness of training.**

The following is taken from DOE-HDBK-1001-96.

Qualification requirements should be established and documented for all facility and subcontract personnel, including occasional/casual instructors who perform training activities. These requirements should be based on instructor qualification levels, and should address instructional competence, technical competence, and applicable interpersonal skills. All subcontract instructors should meet the qualification requirements for the subjects they teach and/or develop.

Instructor trainees who are not fully qualified, as well as occasional instructors, should have limited participation in instructional activities. These individuals should perform assignments under the direct supervision of a qualified instructor or a training supervisor. All instructor trainees who are assigned instructional activities should be formally evaluated by a qualified instructor or a training supervisor.

On a case-by-case basis, determined by testing or experience, an instructor trainee may be granted an exception to specific training program requirements. If an instructor trainee can demonstrate mastery of some/all of the course learning objectives prior to the training, an exception is warranted.

Administrative procedures should be developed that allow training management the option of releasing such an individual from portions of a qualification program's requirements. All exceptions granted should include a written justification.

A job analysis for a DOE facility's instructors and instructional technologists is not required. However, it is recommended that each facility analyze its work activities to ensure that training-related tasks and their associated knowledge and skills are identified and documented for each instructor qualification level. Analysis results should be compared to the facility's instructor training programs to verify that required knowledge (at the proper cognitive level) and skills are provided in the content of each program. Further, these

analyses should be used to establish entry-level requirements (education, training, and work experience) for each instructional qualification level.

The knowledge and skills developed by the facility's instructor training programs should also be compared with the representative instructional competencies. This comparison should help to verify the adequacy of, or identify deficiencies in, the facility's analyses, and should also identify generic competencies that may not be needed in facility-specific training programs.

Competencies that are identified as applicable to a specific instructor training program should be rewritten in the form of terminal and enabling learning objectives.

In all cases, programs should be in place to develop the specific knowledge and skills required for each instructor's qualification level. It is recommended that if a facility does not conduct its own analysis of training-related activities, the content of its instructor training programs should be based on a systematic evaluation process.

Training staff who perform as instructors in the development, presentation, or evaluation of technical topics should possess technical qualifications consistent with their assignments. Technical qualifications should include theoretical and practical knowledge as well as practical work experience at or above the level that is required of the trainee population. Instructors who initially lack practical work experience should complete portions of operator/technician/craft training programs related to the topics taught. These instructors should thoroughly understand the subject matter and its relationship to overall facility operation.

Each facility should establish written procedures that stipulate what these technical qualifications will be, to whom they apply, and how they may be attained for each instructor qualification level. For example, instructors at DOE category A reactor facilities who teach subjects such as technical safety requirements, operating practice, and control manipulations to certified reactor operators and senior reactor operators should have received senior reactor operator (or equivalent) training. Instructors who teach integrated facility response at DOE non-reactor nuclear facilities may also need facility operator (or equivalent) training.

To establish and maintain effective instructor training programs, a periodic or continuing evaluation of each program is necessary. The frequency of these course evaluations should change over time. Following initial training program development, evaluation on a three to six month period may be required. After this initial period of evaluation and course modification, evaluations should be conducted on a one- to two-year frequency.

Evaluation relies on effective two-way communication between the instructional technologists, the course instructors, the training supervisors, and the instructor trainees. Evaluations should encourage program updating and guide program improvements. Program evaluations should include the following items:

- Trainee examination (evaluation) results from the instructional basics and qualification level specific instructor training
- Task-based feedback from former trainees to assess program effectiveness
- Post-training surveys of training supervisors to assess adequacy of program content
- Instructor performance evaluations by trainees, training supervisors, and appropriate line management

- Deficiencies noted in other evaluations and the resulting corrective actions
- Review of DOE and industry guideline/good practices documents
- Review of competency lists versus content of current instructor training programs

Changes in program content, instructional materials, training methods, examination techniques, training facilities, or instructional staff should be identified and assigned to training management representatives for action. Responsibility for tracking corrective actions should also be assigned.

3. **Technical training personnel shall demonstrate the ability to plan, conduct, and document a training needs assessment or job analysis of a position to determine the training requirements associated with that position.**
  - a. **Using DOE-HDBK-1078-94, Training Program Handbook: A Systematic Approach to Training, Section 2 and associated attachments, DOE-HDBK-1074-95, Alternative Systematic Approach to Training, DOE-HDBK-1076-94, Table-Top Job Analysis, and DOE-HDBK-1103-96, Table-Top Needs Analysis, describe in detail the process for identifying and documenting performance-based training requirements (including alternate methods). Discuss the conditions for using an alternate methodology.**

The following is taken from DOE-HDBK-1078-94.

The process descriptions contained in this section describe a systematic approach to identifying and documenting performance-based training requirements. The types of analysis used for identifying training requirements include needs analysis, job analysis, and task analysis. These analyses will provide assurance that training is the appropriate solution to performance problems and identify requirements that serve as the basis for the design and development of performance-based training programs.

#### *Determine Training Needs*

Training needs are initially identified by reviewing regulatory requirements and existing training programs, and/or conducting a needs analysis. These activities enable facilities/sites/offices to determine training needs originating from performance problems, regulatory requirements, and in some cases, requests for additional training or changes to existing training.

A needs analysis can identify solutions to job performance discrepancies. Substandard performance may be related to faulty equipment, inadequate procedures, attitude of the workforce, etc. Prior to developing new courses or modifying existing training programs, a needs analysis should be conducted to determine that training is the appropriate solution. Proper conduct of the analysis identifies the root cause(s) and serves as a basis for future plans to correct identified performance discrepancies.

#### *Develop a Valid Task List*

A job analysis is conducted to develop a detailed list of duty areas and tasks for a specific job or position. It can also supply information to develop a job/position description, if desired. Job analyses also allow comparison of existing training programs to established requirements

and identify deficiencies in the adequacy of program content. For existing programs, the job analysis provides reasonable assurance that all tasks essential to safe and efficient operation are addressed by the training program. It also identifies parts of the training program that are unnecessary, thus resulting in a more effective training program and more efficient utilization of resources. For facilities/sites/offices developing new programs, the job analysis provides the information necessary to identify tasks associated with the job. Training design and development activities can then be based on actual needs, as opposed to perceived needs.

All pertinent information regarding position-specific job analyses should be documented in a job analysis report, which becomes part of the training program file for each specified position. This report describes the process/methodology used to conduct the job analysis, the names and positions of individuals conducting the analysis, and the results of the analysis.

The first step in job analysis is a review of available job information. This review provides input to an initial list of tasks and duty areas, and serves as the starting point for further analysis. In addition to the information obtained from the review, SMEs from the prospective user group are consulted for compilation of task lists.

Questionnaires are prepared for distribution to job incumbents. They are used to verify the accuracy and validity of the initial task list and identify which tasks will be selected for training. The job incumbent is asked during the survey to assign ratings in the following categories: task importance, task difficulty, and task frequency.

Survey results are compiled and analyzed by the training organization. As a minimum, the reported results should contain the following.

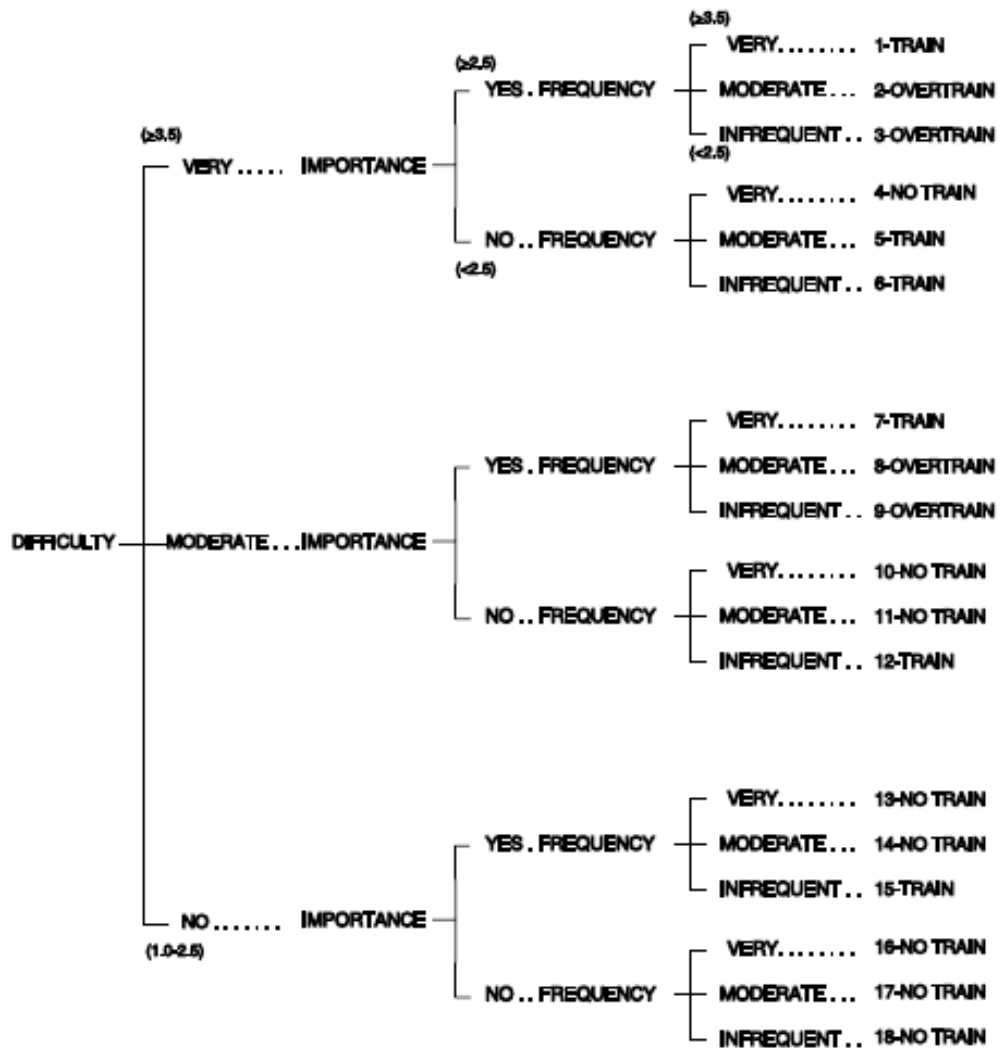
- frequency of task performance;
- importance (consequences of inadequate performance);
- difficulty of task performance; and
- all additional tasks, identified by survey respondents, that were not included in the initial survey.

### *Select Tasks for Training*

After analyzing the survey results the numerical averages of the responses are used to identify which tasks will be selected for training. Tasks are selected or deselected for training using a systematic process similar to the one illustrated in figure 2.

After the criteria have been established, the numerical average of each of the tasks is inserted into the decision tree (figure 2) and the proper path is chosen. Tasks should then be sorted into groups according to similar combinations of average difficulty, importance, and frequency ratings as shown in figure 1. The decisions arrived at using this procedure result in a grouping of tasks along a scale so that one end of the scale contains difficult, important, and frequently performed tasks; the other end of the scale contains the easy, less important, and infrequently performed tasks. Tasks that are identified as No Train should be reviewed by SMEs and supervision to assure that no formal training is needed.





Source: DOE-HDBK-1078-94

**Figure 2.** Criteria for selecting tasks for training

#### *Prepare a Task-to-Training Matrix*

The purpose of a task-to-training matrix is to provide one document that can be used to guide the maintenance of a training program. It provides a ready reference for evaluating the impact of procedure changes, criteria for selecting tasks for training, updated technical information, revised learning objectives, etc.

#### *Conduct an Analysis of Existing Training Material*

At this point in the analysis phase, a comparison of existing training materials should be conducted. This is best accomplished using a committee made up of at least three SMEs and one or two knowledgeable people from the training organization. Existing lesson plans, lesson guides, OJT guides, and test questions, etc., should be reviewed to ascertain whether the existing materials are adequate.

### *Conduct a Task Analysis*

As training is designed and developed for the tasks selected for training, each task should be analyzed to determine the KSAs required for satisfactory accomplishment of the task.

### *Application of Job or Task Information*

Information collected during the analysis is translated into training program requirements. Analysis data are also used to validate training program content and ensure that training reflects actual job requirements for both existing and newly developed material.

### *Alternate Methodologies*

The following is taken from DOE-HDBK-1074-95.

There are several traditional systematic approaches to training, including performance-based training, instructional systems design, and criterion referenced instruction. These approaches all have common elements that are:

- Job Based. Training focuses on the job.
- Sequential. The program is logically and sequentially integrated.
- Tracked. A tracking system is established that allows changes and updates to training materials to be accommodated efficiently.
- Evaluated. Evaluation and corrective action allows continuous improvement and maintenance of training information that reflects current status and conditions.

Grading of training efforts and using alternatives to the more traditional SAT techniques should not be misconstrued to mean a reduction in quality. Rather, the level of detail and formality are tempered by factors such as hazard and risk, cost-benefit, and productivity. Regardless of the hazard associated with a facility, some jobs and many tasks are low risk. The development of training for any job/task should be graded.

The fundamental elements of SAT are the key and a fundamental SAT approach is reflected throughout. Alternative techniques streamline the processes that have historically been driven by formal guidance documents. The following alternatives to traditional approaches is presented to help management consider and select the most reasonable and cost-effective technique(s) for the specific training and facility needs.

### *Table Top*

The table-top process is facilitated by a person who is familiar with table-top techniques and application of the results. For the table-top technique to be effective, a minimum of one job incumbent and one supervisor are needed to discuss the task(s) or topic(s). The facilitator conducts the session(s) and documents the information. The success of this technique depends primarily on the expertise of the group and the facilitator's ability to extract and summarize information and learning strategies. This process is most useful and effective in analysis, design, and development.

### *Verification*

This technique allows training program products to be determined based on work at other facilities on the same or similar tasks or topics. This process can save significant effort and

cost. Communication with or benchmarking visits to both government and private facilities will enable facilities to take advantage of existing experience and materials. Industry analyses that can be adapted to DOE nuclear facility positions are available for many of the reactor operator, reactor supervisor, maintenance, and technician positions. Use of these lists require the help of SMEs and a trained facilitator. These experts use the lists to decide which tasks apply and to identify the tasks that require modification to reflect job requirements. Other sources of information and industry guidelines that may identify job-related training requirements include guides to good practices, DOE technical standards, other DOE facilities, commercial nuclear utilities, and vocational programs.

#### Document Analysis

This technique is especially valuable when accurate procedures and other job-related documents are available. Document analysis is a simplified technique for determining required knowledge and skills directly from operating procedures, administrative procedures, and other job-related documents. An SME and a trainer review each section and step of the procedure or document to determine training program content.

#### Templating

Training content can be determined by the careful review/analysis of a template. The template technique uses a simplified process for determining content or developing learning objectives associated with the operation or maintenance of a specific facility system. This technique produces generic and system-specific learning objectives for the training and evaluation of facility personnel. Some facilities have approached the design of training based on the systems an individual operates or maintains. A template containing generic learning objectives is reviewed by SMEs for applicability. This approach directly generates system-specific terminal and enabling learning objectives. It is important that the template be carefully reviewed to determine the applicability of each item to the system. If this review is not accomplished, the result can readily become “know everything about everything.”

- b. **Identify a position to be assessed.**
- c. **Gather appropriate reference and resource materials related to the position.**
- d. **Interview subject matter expert(s) and supervisors associated with the position to determine the duties and responsibilities in terms of tasks and/or competencies.**
- e. **Determine the knowledge, skills, and abilities (or specific training) required to support the identified duties and responsibilities.**
- f. **Assist employees with the preparation of their individual development plans (IDPs), using the results of job/position and task analyses, and related information.**
- g. **Compile the IDPs and other training needs information into an organizational needs assessment, and prepare a prioritized (according to organizational requirements) listing of annual training and education needs.**
- h. **Research and present the findings to office management of how a developmental need is fulfilled.**
- i. **Validate the results of the needs assessment with other SMEs and/or the responsible supervisor.**

Elements b through i are performance-based KSAs. The qualifying official will evaluate their completion.

- 4. **Technical training personnel shall demonstrate a working-level knowledge of training course and/or program design techniques and methodologies.**
  - a. **Using DOE-HDBK-1078-94, Training Program Handbook: A Systematic Approach to Training, Section 3 and associated attachments, DOE-HDBK-1074-95, Alternative Systematic Approach to Training, DOE-HDBK-1086-94, Table-Top Training Program Design, describe the following:**
    - **Process for designing training programs (including alternate methods);**
    - **Conditions for using alternate methodologies; and**
    - **Entry-level requirements and how they influence the training program or course design.**

**[Note: DOE-HDBK-1086-94 is actually DOE-HDBK-1086-95.]**

The following is taken from DOE-HDBK-1078-94.

#### *Process for Designing Training Programs*

The approach described in the following paragraphs outlines the basic processes used to design training programs that are based on the job-related/performance-based information collected during analysis. This information is divided into the major headings of the design process.

Write terminal objectives. Terminal learning objectives are learning objectives that clearly state the measurable performance the trainee will be able to demonstrate at the conclusion of training, including conditions and standards of performance. They are translated directly from the task statement, and provide the framework for the development of training/evaluation standards, enabling objectives, and lesson plans. Care must be taken when developing and writing learning objectives. Trainees must clearly understand them, or they are of limited use. Related terminal objectives must be written for each task statement before any other design work is begun.

When writing a terminal objective, the training setting must be considered since it must be balanced against available resources and facility constraints. The training setting is the environment in which training is conducted and should be consistent with the task. Training settings include self-paced instruction, OJT training, simulation, laboratory/workshop training, and classroom instruction.

All terminal objectives for tasks identified for inclusion in the training program must now be sequenced and organized into instructional areas. Objectives are normally sequenced from simple to complex. The sequence should allow each terminal objective to build on and provide information necessary to support the next terminal objective within that instructional area. They should be sequenced in a logical progression that takes into account the level of learning that must take place to build to the next objective. This will ensure the entire training program is sequenced correctly.

Develop training/evaluation standards (TESs). After the terminal objectives have been written, it is necessary to ensure that training materials are directly linked to the objectives. The development of a TES can help to ensure that this vital link is maintained. The purpose of the TES is to provide the basis for the development of objective-based training materials and to maintain consistency in the evaluation of student performance. Each TES is directly related to a specific job task (or group of very similar tasks) identified during job analysis.

The following steps are performed when developing the TES:

- Determine testing limitations
- Determine elements of the task to be tested
- Identify KSAs
- Determine entry-level requirements
- Determine amplifying conditions and standards
- Write enabling objectives
- Determine scoring methods

Enabling objectives are learning objectives that support the terminal objective. They include the critical components of performance, conditions, and standards. Enabling objectives should be written directly from the KSAs required for element performance. Any identified KSAs that are not included in the entry-level requirements must be incorporated into an enabling objective.

Enabling objectives should be sequenced logically, moving from simple to complex and from lower to higher levels of learning. Often, the required sequence will drive the outline and content of the lesson plan and other training material. If TESs are developed for all tasks

identified for a particular training program, enabling objectives that are common to several tasks may be grouped into one lesson of instruction. This grouping can increase the efficiency and cost effectiveness of a training program by reducing duplication. For this reason, a computerized system that can sort by enabling objective title can be invaluable.

Scoring methods are determined when constructing the evaluation section of the TES. In some evaluation standards, referenced procedures may provide detailed, step-by-step descriptions of required performance, and therefore provide an effective scoring method.

Another method is to prepare a performance checklist that incorporates the action steps or elements of task performance. The trainee is required to follow each step, usually without deviation. When developing the TES, items that can be scored must be clearly defined to distinguish between satisfactory and unsatisfactory performance.

Develop test items. Test items are developed to be consistent with the learning objectives. The purpose of the test item is to measure trainee performance against the criteria stated in the learning objective. The test item development sequence is as follows:

- Determine test item format
- Determine the number of test items to be developed
- Develop skill and knowledge test items
- Validate content of test items
- Incorporate items into test bank for future use

Construct tests. The construction of tests at this time is optional. However, tests must be constructed prior to implementing the training program. Tests are a form of evaluation that instructors can use to measure the results or effectiveness of their stated objectives. Test items should be constructed and scored in an objective, rather than subjective, manner. An objective test can be scored without the exercise of personal opinion. The length of a test should not exceed the number of test items which could be answered in two hours by the average trainee. This may require assembling several tests for a given instructional area. The following steps are involved in the development of tests:

- Develop test specifications
- Assemble the test

Write a training development and administrative guide. A training development and administrative guide should not be confused with the facility's training management manual that outlines the facility training policies and procedures that guide the development of all training. A training development and administrative guide is a management tool for the administration of an individual training program. It is used to gain management approval of the program and guide development and implementation efforts. Though not part of this guide, additional specifications may be developed to clarify and detail the required characteristics of individual courses or lessons. Approval should include training management and the management of the organization for which the training is being developed.

Alternate design. An alternate, table-top approach to design is used to determine and design the content of a training program. The table-top method typically involves the following steps:

- Developing a curriculum outline

- Determining the content of each training session and writing learning objectives, and determining the appropriate learning strategy (instructional method and setting)
- Determining testing requirements

### *Conditions for Using Alternate Methodologies*

The following is taken from DOE-HDBK-1074-95.

Using alternatives to the more traditional methods of establishing systematic training programs can significantly reduce the time and effort associated with the training process. Alternative approaches streamline analysis, design, development, implementation, and evaluation of training materials and programs. Alternative delivery mechanisms such as structured self-study, computer-based training, or interactive video/multi-media should also be considered where appropriate.

Techniques range from very simple to elaborate. The least elaborate techniques are typically used for the training of managers, the technical staff, and oversight personnel. For these positions, the training process may only require (1) an evaluation of the job to determine significant job requirements, (2) an evaluation of the education, experience, and prior training of job incumbents to identify deficiencies between job requirements and the individual's current qualifications, and (3) implementation of a plan for the individual to correct the identified deficiencies. The plan may include temporary rotational job assignments; mentoring; required reading; attendance at workshops, seminars, and professional society meetings; and training on specific areas that are applicable to the job requirements.

More elaborate techniques, typically necessary for higher risk jobs such as fissile material handlers, reactor operators, and senior reactor operators, would normally involve some form of job and task analysis followed by development of detailed learning objectives, lesson plans, job performance measures, etc.

Regardless of the techniques used, a strong evaluation process is necessary to ensure effective implementation, timely updates, and periodic improvements.

### *Entry-Level Requirements and How They Influence the Training Program or Course Design*

The following is taken from DOE-HDBK-1078-94.

In every training program, the entry-level KSAs of the trainee must be considered. By properly establishing the entry-level requirements, new learning will be based on what the trainees already know, and the trainees will not be wasting time on objectives they have already mastered.

The entry-level requirements should be based on a familiarity with the general level of KSAs of the trainees, and by a careful review of documents such as job descriptions, position descriptions, or personnel qualification requirements. The entry-level requirement should be set at a point where most trainees have the required KSAs. Any required KSAs that the trainees do not possess upon entry will have to be taught as part of the overall training program. Remedial lessons may be necessary for those trainees who do not meet the entry-level requirements.

One way to determine the entry level is to develop and administer an entry-level test. This test can determine if personnel meet the entry-level requirements, and serves to focus the training at the appropriate level. This can be especially helpful when evaluating an existing program since it allows comparison of the existing job incumbent training level to the desired level. It should be noted that entry-level testing is optional and can be affected by contractual agreement. It is essential, however, that a system be in place to enable verification that trainees meet the established entry-level requirements. The system should include a course of action for those personnel who fail to meet the requirements.

**b. Using DOE-HDBK-1200-97, Guide to Good Practices for Developing Learning Objectives, describe the process for developing learning objectives stressing following:**

- **Development and validation of learning objectives;**
- **Differences between terminal and enabling learning objectives;**
- **Attributes of well-written objectives; and**
- **Grouping and sequencing of learning objectives.**

*Development and Validation of Learning Objectives*

The following is taken from DOE-HDBK-1200-97.

The development of effective training materials is dependent on the development of learning objectives which adhere to a strict set of criteria. Learning objectives are developed from analysis information obtained during the design phase of the SAT process. It is important that objectives are developed and approved early since they form the foundation for the development of test items and all other training material.

Because objectives serve as the design basis of performance-based training programs, they should clearly describe the trainee's desired performance to preclude misinterpretation. Some of the benefits of using learning objectives are listed below:

- Standards of performance are presented in a trainee-accessible way.
- Criteria for evaluation are defined.
- Learning requirements are clarified and explicit.
- Content, methods, media, and resources are derived and related to objectives.
- Focus is provided for the instructor and the trainee.

*Differences between Terminal and Enabling Learning Objectives*

The following is taken from DOE--HDBK-1078-94

Terminal learning objectives are learning objectives that clearly state the measurable performance the trainee will be able to demonstrate at the conclusion of training, including conditions and standards of performance. They are translated directly from the task statement, and provide the framework for the development of TEs, enabling objectives, and lesson plans.

Enabling objectives are learning objectives that support the terminal objective. They include the critical components of performance, conditions, and standards. Enabling objectives should be written directly from the KSAs required for element performance.



### *Attributes of Well-Written Objectives*

The following is taken from DOE-HDBK-1200-97.

All effective learning objectives have certain characteristics. The developer should always take the following characteristics into consideration when constructing objectives:

- Attainable: Is the objective possible to achieve by the average trainee?
- Specific: Is the wording concise? Has unnecessary and confusing verbiage been removed?
- Clear: Will everyone interpret the objective in the same way?
- Measurable: Can this behavior be measured? How? With what kind of gauge?

Effective learning objectives can be stated in a variety of formats. The most common format combines condition, action, and standard statements. This combination explicitly defines the condition under which the performance occurs, what knowledge or skill is exhibited, and the standards of acceptable performance.

Condition statement. The condition statement establishes the circumstances under which the trainee must be able to perform the specified action. Conditions are derived from information collected during analysis of the task. They also include equipment, tools, and references necessary to perform the task.

Condition statements can generally be considered as either aiding or limiting. An aiding condition advises the trainee of things that will be available to assist in performance of the specified action. A limiting condition advises the trainee of limitations which are likely to make the action more difficult to perform.

Action statement. The action statement is the nucleus of the objective and should therefore describe exactly the performance required of the trainee on the job. It should be precise, observable, and should be based on the task, element, skill, or knowledge statements resulting from the analysis of the task. The action statement consists of an implied subject (you), a verb, and the verb's object.

Standard statement. The standard statement describes what criteria must be met for the performance specified by the action statement to be considered acceptable. The standard for the objective should be derived from the standard required by the task. The developer of learning objectives must always remember to strive for standard statements that closely approximate actual performance criteria. The standard will refer to the quality of the end product or the precision of the process and is usually expressed in terms of time limits, accuracy, quality, or quantity.

### *Grouping and Sequencing of Learning Objectives*

The following is taken from DOE-HDBK-1078-94.

All terminal objectives for tasks identified for inclusion in the training program must be sequenced and organized into instructional areas. Objectives are normally sequenced from simple to complex. The sequence should allow each terminal objective to build on and provide information necessary to support the next terminal objective within that instructional area. They should be sequenced in a logical progression that takes into account the level of

learning that must take place to build to the next objective. This will ensure the entire training program is sequenced correctly.

Enabling objectives should be sequenced logically, moving from simple to complex, and from lower to higher levels of learning. Often, the required sequence will drive the outline and content of the lesson plan and other training material. If TESs are developed for all tasks identified for a particular training program, enabling objectives that are common to several tasks may be grouped into one lesson of instruction. This grouping can increase the efficiency and cost effectiveness of a training program by reducing duplication. For this reason, a computerized system that can sort by enabling objective title can be invaluable.

**c. Describe and differentiate the design features for the various training settings (including technology-supported learning) that may be selected when designing a training curriculum.**

The following is taken from DOE-HDBK-1078-94.

Training settings include self-paced instruction, OJT, simulator training, laboratory/workshop training, and classroom instruction.

*Self-Paced Instruction*

Self-paced instruction is any form of instruction that does not require the presence of an instructor at the training setting. However, feedback must be provided. Self-paced instruction can be in printed form, in audiovisual form, in the form of a kit that can be assembled or manipulated, or in the form of a computer-assisted instruction program. Training that meets the following conditions can be considered for self-paced instruction:

- Training for the task does not require close supervision. Unsupervised training is not likely to result in injury to employees or damage to plant equipment. In addition, immediate feedback from a supervisor is not required for the trainee to achieve mastery.
- New personnel are not required to perform the tasks immediately.
- All conditions can either be provided in the training materials or made available in the facility when needed by the trainee. Tasks that require special facilities, conditions, or equipment not readily available in the facility should be considered for another training setting.
- The task does not require extended periods to achieve mastery. Tasks that are very difficult or extremely difficult suggest lengthy training durations and are more suited to settings that provide supervision and immediate feedback.

*OJT*

OJT is formal training that is conducted and evaluated in the work environment. If the job permits the assignment of tasks to OJT, and a system is in place to handle the administration and testing involved in OJT, tasks can be considered for assignment to this setting. OJT has the advantage of providing continuous training on tasks that are of immediate need to the trainee. Further, OJT can continue for whatever length of time is necessary for the trainee to achieve mastery.

OJT is limited to those situations where it is administratively possible to conduct the training and where OJT can be conducted without interference to ongoing facility operations.

Training that meets the following conditions can be considered for OJT:

- Assignment of trainees can be made in small groups and spread over a sufficiently long period of time.
- There are no critical resource (manpower, material, facility availability) constraints in the plant, and multiple training conditions can be provided in the job environment.
- Qualified personnel are available to conduct OJT.

### *Simulator Training*

Simulator training is training that is conducted in or on a device that duplicates the work environment in the physical appearance; operating conditions during normal, abnormal, and emergency conditions; and indications associated with the actual work environment. This setting, though expensive, is suited for training tasks requiring a high degree of trainee-system interaction, but for which OJT is not appropriate. For example, some of these tasks are performed infrequently and would not be encountered normally in the course of OJT.

Tasks that meet the following conditions can be considered for simulator training:

- Similarity to the actual task is required for the trainee to achieve mastery.
- Problem diagnosis under stressful situations is an integral part of performance.
- Teamwork is an important part of the task.
- Training of the tasks in the OJT setting would interfere with ongoing facility operations, would introduce unnecessary safety hazards, or would not be encountered in the course of normal job operations.
- A simulator exists or can be obtained that sufficiently resembles the physical and operational characteristics of the facility.
- The physical performance skills and system interaction components of the tasks are sufficiently great to require a fair amount of repetitious practice.

### *Laboratory/Workshop Training*

Laboratory/workshop training is training that emphasizes hands-on, practical experience in a controlled environment, but which is not necessarily conducted at the actual job site.

Laboratory/workshop training should be considered if multiple job conditions (environment, system, equipment, etc.) are required for task performance. Laboratories and workshops permit application of course material by the trainees in a hands-on environment. They are particularly effective when used to train basic skills that support task performance. Training that meets the following conditions can be considered for laboratory/workshop instruction:

- Tasks, elements, and skills require hands-on practice to achieve mastery.
- Constraints exist that make OJT impractical.

### *Classroom Instruction*

Classroom instruction is training presented to groups of various sizes, typified by stand-up lecture, seminar, or group interaction. Classroom instruction works well for presentation of fundamental and basic theoretical knowledge. Because a classroom training setting does not replicate OJT conditions, it is recommended that a combination of classroom and other settings be used in the course of instruction. Training that meets the following conditions can be considered for classroom training:

- Large quantities of information will be presented during training.

- A large group of trainees will be scheduled for training at a given time.
- Other training settings are not suitable or available.
- There are no critical resource constraints. (Everything required for training can be provided at the classroom facility.)

When evaluating the design of an existing training program or addressing a performance deficiency, determine if the current training setting for the task is the best instructional choice. If it is not, it may be necessary to select another training setting and/or modify the learning objectives and lesson material to incorporate the setting selected. For new programs, evaluate each setting and select the setting most consistent with the task, taking into account available resources and facility constraints. Write the terminal objective based on the task and the setting.

**d. Prepare the learning objectives and identify the corresponding media, method, or setting for an assigned training program or course.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion.

**5. Technical training personnel shall demonstrate a working-level knowledge of the process, techniques, and methodology associated with training material development.**

**a. Explain why formal and documented training materials are necessary in a formal, systematic approach to the training process.**

The following is taken from DOE-HDBK-1078-94.

Training support materials refer to training equipment, audiovisual media, and printed material. When selecting or developing training support materials, the type of material is influenced by the learning objectives and method of instruction. Materials should support the learning objectives and emphasize job-related information and situations. The lesson specifies what training materials are required and when. The following steps are performed when developing training materials.

*Specify Use of Audiovisual Media*

The use of audiovisual media in presenting course material can help maintain trainee interest and motivation, and can improve training efficiency and effectiveness. Media to be considered include simulation, computer-aided instruction, film or videotape, sound slide or film strip, audio recorder, transparencies, and written handouts.

The characteristics of a learning activity may suggest that a medium with certain audiovisual capabilities will be more effective in displaying or transmitting the desired information to the trainees. These characteristics are visual, visual movement, exact scale, and audio. Each learning activity must be analyzed to determine which of the characteristics should be reflected in the audiovisual capabilities of the medium. These four characteristics are not independent, and combinations of them may be needed to display or transmit the information effectively. The media selected should be evaluated in terms of cost and practicality of use in the training program. Factors to be considered in these evaluations include the following:

- Projected life-cycle costs of the selected media

- Budgetary resources available, particularly if the media requires a substantial capital investment
- Appropriateness of the media for the number of trainees to be trained at a given time
- Frequency of changes to media
- Compatibility with existing programs
- Lead time required to produce the media

### *Review and Select from Existing Materials*

Developing effective training materials requires creativity and is both costly and time-consuming. Adopting or modifying existing materials can reduce training development costs. Existing course materials should be collected and reviewed to determine if they meet, in whole or in part, the needs of the training program. Material selection should be based on an evaluation of existing materials against the following criteria:

- Is it appropriate to expected trainee entry-level skills and knowledge?
- Does it cover the learning objectives?
- Is it consistent with learning activities?
- Is it compatible with the training development and administration guide for the program?

The review and analysis of existing course materials will identify materials to be rejected, materials to be accepted without revision, and materials to be revised. The materials that are suitable without revision should be incorporated into the development process.

### *Modify Existing Training Materials*

Modifying existing training materials can minimize development time and conserve resources. The modification process can involve two approaches: revision of existing training materials that are free of copyright restrictions, or preparation of supplementary material for training materials under copyright restrictions. Modification should be considered when existing materials are incomplete or minor changes are needed, as in the following examples:

- Additional information is needed to meet the requirements of the learning objectives and learning activities.
- Minor modifications to facility systems, equipment, and/or procedures require an update or change.
- Minor changes in regulations require an update or change.
- Industry operating and maintenance experiences necessitate a minor update or change.

Existing materials that are incomplete or require minor modification should be modified using the following guidelines:

- The style and reading level of the modification should be consistent with the existing materials.
- Modifications should be inserted into existing material where needed.
- Some redundancy may be necessary to provide continuity between the modifications and the existing materials.

### *Develop New Materials*

Development of new training materials should be consistent with the learning objectives and should reflect the learning activities to ensure that the trainees progress through training in an

organized and efficient manner. Training materials should be developed using guidelines that are intended to promote learning. The guidelines include formatting that will ensure ease in trainee use. For example, charts, graphs, tables, and other illustrations that are effective in emphasizing key points should be located on a separate page and in close proximity to related information. The reading level of training materials should be consistent with the expected entry-level skills and knowledge of the trainees. Essential information should be located in the materials, and the trainees should not be referred to other places for that information. More than one representation of key or complex information should be included in the materials. Relating the information in a job context is an effective way to promote learning. This should include a description of the job environment, how the information will be applied on the job, and the reasons why it is important for the trainee to learn the information.

**b. Explain the relationship between learning objectives, training materials, and the presentation of instruction.**

The following is taken from DOE-HDBK-1200-97.

The development of effective training materials is dependent on the development of learning objectives that adhere to a strict set of criteria. Learning objectives are developed from analysis information obtained during the design phase of the SAT process. It is important that objectives are developed and approved early since they form the foundation for the development of test items and all other training material.

When writing a learning objective, the presentation of instruction must be considered since it must be balanced against available resources and facility constraints. The presentation of instruction is the environment in which training is conducted and should be consistent with the task.

**c. Using DOE-HDBK-1078-94, describe the attributes, content, and format of available training methods.**

See competency 4c for a discussion of training methods.

**d. Using DOE-HDBK-1078-94, describe the attributes, content, and format of lesson plans.**

The following is taken from DOE-HDBK-1078-94.

*Lesson Plan Attributes and Content*

Lesson plans are detailed expansions of the curriculum outline that ensure consistency in the delivery of training from instructor to instructor and from student to student. They are used by the instructor as the primary training tool to guide the learning process and utilization of training materials. Lesson plans identify the learning objectives, content, learning activities, training equipment, and training materials needed for training and provide guidance for their use. In addition, properly developed lesson plans perform the following functions:

- Provide a degree of standardization of instruction
- Present a logical, sequential listing of content
- Prevent over- as well as under-emphasis of selected content
- Force instructors to analyze content prior to presentation

- Offer a ready format for revision
- Provide a record of contents presented
- List aids, equipment, and references used
- Provide continuity between the lessons presented within a specific course, especially when several instructors are involved

### *Lesson Plan Format*

The first step in lesson plan development is the determination of format. Instructor and trainee activities should be planned so they occur at the proper stages in the learning process. Once a standard format has been established, it should be used for all lesson plans. This standard format should be specified in the facility training management manual. While the printed design or format of a lesson plan may differ, the lesson plan should include the following:

- Cover page
  - Labeling information
    - Course title and number—a title and a number unique to that lesson plan
    - Lesson title—a title descriptive of the content
    - Lesson time—approximate duration of the lesson
    - Author—name of individual who wrote or last revised the lesson plan
    - Review and approval signatures
    - Date—date lesson plan was approved or last revised
    - Revision number—current revision number
  - Terminal and enabling objectives—the learning objectives for the lesson
  - Training aids and material used—a list of all support material and tests used during instruction with this lesson plan
  - References—all pertinent references used to support the content of the lesson plan (inclusion of page and paragraph for text material is helpful)
  - Prerequisites—any courses, classes, qualifications, etc., required prior to beginning this instruction
- Historical record form
  - A section which includes documentation of the changes made to a lesson plan, why they were made, and who made and approved them
- Presentation content
  - Introduction—a section which includes the purpose of the lesson, the training session conduct and administration, and a statement of the learning objectives
  - Body—the lesson content and trainee and instructor activities
  - Summary—a highlight of important points and review of learning objectives

### **e. Using DOE-HDBK-1078-94, describe the attributes, content, format, and selection of training support material.**

The following is taken from DOE-HDBK-1078-94.

Training support materials refer to training equipment, audiovisual media, and printed material. When selecting or developing training support materials, the type of material is influenced by the learning objectives and method of instruction. Materials should support the

learning objectives and emphasize job-related information and situations. The lesson specifies what training materials are required and when.

**f. Describe the advantages and disadvantages of traditional and nontraditional (such as technology-supported learning) delivery systems, associated materials and media, and such issues as cost and scheduling.**

The following is taken from Florida State University, Training Delivery Systems for Adult Learners.

In the earliest days, people learned from traditional methods, such as one-on-one instruction; craftsmen served apprenticeships; and the children of the wealthy learned essential skills from private tutors. Head-to-head training is still probably the most effective method ever developed, but it is useless for teaching a large number of students.

Private broadcasts let a company's best instructor reach all the pupils at the same time.

Non-traditional methods rely on interactive technologies that adjust to the individual student, and they are fast. Experts claim that computer-based training and interactive video can cut training time in half.

High-tech, non-traditional delivery systems handle many tasks more efficiently than traditional systems. A study conducted by International Business Machines showed non-traditional delivery systems to be about three times more effective at teaching than an instructor, and consultants claim that computer-based training teaches one-third faster than do traditional delivery systems.

Another advantage of machine instruction is that it increases one-on-one interaction. Interactive video and computer-based training force students to participate. Other advantages of high-tech teaching include consistency, efficiency, and economies of scale. Further, students can save their companies time and money by using self-paced instruction that lets them skip lessons they already know and focus on unfamiliar material. Faster learners get back on the job sooner; slower learners can redo a lesson until they get it right, without appearing incompetent.

Tangible savings can be realized using teleconferencing from reductions in training-related travel. Using a business TV network, companies can broadcast training programs to employees at their workplaces.

One disadvantage of video production is the high cost of the hardware. If the company is not training a thousand people it may not be able to justify the cost of non-traditional delivery systems such as video and distance learning media.

These non-traditional delivery systems have limits for training. Videotape cannot hold a still image for very long, and the tape cannot easily go backward when a student's performance indicates the need for review



- g. Using the results of a training needs assessment or job analysis, develop a course outline, learning objectives, and a lesson plan to reflect the required knowledge and skills.**
- h. Develop training materials to support the presentation of an assigned classroom, self-study, or laboratory training session.**

Elements g and h are performance-based KSAs. The Qualifying Official will evaluate their completion.

- i. Describe the methods used to validate training prior to implementation.**

The following is taken from the U.S. Air Force, AFH 36-2235.

Before it can be validated, the training program should be conducted or tried out to see if it does what it is intended to do. There are two ways to try it out: SME validation and trainee validation. These validation methods are further described below.

**SME validation.** Determining who should participate in validating the training depends on who the training is for. Have co-workers sit through the training session. Observe training and see where problems occur or where training can be improved. See how the information is perceived by the trainees. Determine whether the SMEs will have problems understanding what is said, or whether they can perform the procedures based on what they are told. If the SMEs have a problem with the training, it is likely the trainees will also have a problem. This evaluation only points out where the problems may occur. The real test is with the trainees themselves, and often the trainees identify different problems than those identified by the SMEs.

**Trainee validation.** For this type of validation, use the actual trainees who need the course. The test group should know where problems exist and where improvements can be made in the training. Remember, the training session is for the trainees, not the trainer. They need to learn the material to be able to perform the job. The better the material is, the more they will learn.

- 6. Technical training personnel shall demonstrate a working-level knowledge of adult learning methodologies, instructional media and methods, and instructor techniques required to conduct a training session or evaluate the effectiveness of training sessions.**
  - a. State and discuss the factors that an instructor can control that affect learning during classroom instruction, including a discussion of dealing with difficult trainees.**

The following table is taken from Honolulu Community College, Difficult Behaviors in the Classroom.

**Table 1.** Difficult behaviors and possible responses

Behavior	Possible Responses
<p>Rambling, wandering around, getting off the subject, using far-fetched examples or analogies</p>	<ul style="list-style-type: none"> <li>• Refocus attention by restating relevant points.</li> <li>• Direct questions to the group that focus back on the subject.</li> <li>• Ask the trainee how his/her topic relates to the current topic being discussed.</li> <li>• Use visual aids, begin to write on the board, or turn on the overhead projector.</li> <li>• Ask: "Would you summarize your main point please?" or "Are you asking...?"</li> </ul>
<p>Shyness, silence, or lack of participation</p>	<ul style="list-style-type: none"> <li>• Change teaching strategies from group discussion to individual written exercises or a videotape.</li> <li>• Give strong positive reinforcement for any contribution.</li> <li>• Involve the trainee by directly asking him/her a question.</li> <li>• Make eye contact.</li> <li>• Appoint the trainee to be a small-group leader.</li> </ul>
<p>Talkativeness, knowing everything, manipulative behavior, or chronic whining</p>	<ul style="list-style-type: none"> <li>• Acknowledge comments made.</li> <li>• Give limited time to express viewpoints or feelings, and then move on.</li> <li>• Make eye contact with another participant and move toward that person.</li> <li>• Give the person individual attention during breaks.</li> <li>• Say: "That is an interesting point. Now let's see what other people think."</li> </ul>
<p>Sharp shooting, trying to shoot you down or trip you up</p>	<ul style="list-style-type: none"> <li>• Admit that you do not know the answer and redirect the question to the group or to the individual who asked it.</li> <li>• Acknowledge that this is a joint learning experience.</li> <li>• Ignore the behavior.</li> </ul>
<p>Heckling/arguing, disagreeing with everything you say, or making personal attacks</p>	<ul style="list-style-type: none"> <li>• Redirect questions to the group or to supportive individuals.</li> <li>• Recognize the participant's feelings and move on.</li> <li>• Acknowledge positive points.</li> <li>• Say: "I appreciate your comments, but I'd like to hear from others," or "It looks like we disagree."</li> </ul>
<p>Grandstanding, getting caught up in one's own agenda or thoughts to the detriment of other learners</p>	<ul style="list-style-type: none"> <li>• Say: "You are entitled to your opinions, beliefs, or feelings, but now it's time we moved on to the next subject," or "Can you restate that as a question?" or "We'd like to hear more about that if there is time after the presentation."</li> </ul>

Behavior	Possible Responses
Overt hostility/ resistance, angry, belligerent, or combative behavior	<ul style="list-style-type: none"> <li>• Hostility can be a mask for fear. Reframe hostility as fear to depersonalize it.</li> <li>• Respond to fear, not hostility.</li> <li>• Remain calm and polite. Keep your temper in check.</li> <li>• Don't disagree, but build on or around what has been said.</li> <li>• Move closer to the hostile person and maintain eye contact.</li> <li>• Always allow him/her a way to gracefully retreat from the confrontation.</li> <li>• Say: "You seem really angry. Does anyone else feel this way?"</li> <li>• Solicit peer pressure.</li> <li>• Do not accept the premise or underlying assumption if it is false or prejudicial, e.g., "If by queer you mean homosexual..."</li> <li>• Allow the individual to solve the problem being addressed. He/she may not be able to offer solutions and will sometimes undermine his/her own position.</li> <li>• Ignore the behavior.</li> <li>• Talk to him or her privately during a break.</li> <li>• As a last resort, privately ask the individual to leave class for the good of the group.</li> </ul>
Griping and possibly legitimate complaining	<ul style="list-style-type: none"> <li>• Point out that we can't change policy here.</li> <li>• Validate his/her point.</li> <li>• Indicate you'll discuss the problem with the participant privately.</li> <li>• Indicate time pressure.</li> </ul>
Side conversations, whether related to the subject or personal	<ul style="list-style-type: none"> <li>• Don't embarrass talkers.</li> <li>• Ask their opinion on the topic being discussed.</li> <li>• Ask talkers if they would like to share their ideas.</li> <li>• Casually move toward those talking.</li> <li>• Make eye contact with them.</li> <li>• Comment on the group (but don't look at them one-at-a-time).</li> <li>• Standing near the talkers, ask a nearby participant a question so that the new discussion is near the talkers.</li> <li>• As a last resort, stop and wait.</li> </ul>

*Source: Honolulu Community College, Difficult Behaviors in the Classroom*

**b. Describe the attributes of an effective classroom learning environment.**

The following is taken from TechSoup, Essential Elements of Effective Classroom Training.

Effective classroom training should be viewed as a three component process. If any one component is weak or missing, it can make for unsuccessful training. The three important components of effective classroom training are: the trainer, classroom, and content.

### *Trainer*

A student should expect a training experience that includes quality instruction from an effective trainer, documentation, hands-on activities, and additional resources as needed. Trainers do not have to be experts, but they should be capable of fielding questions and following up with further research. Documentation should be clear and provide the information necessary for students to use what they have learned when they return to work. Additional resources about any given topic are inevitably needed, too. Resources that provide more information for further research and training are an important part of the learning process. As technology continues to change, students need to know how to keep up with new trends and distill what is important. A seasoned trainer will clearly outline learning objectives for the class at the outset. This can help demystify the learning process for the student.

There are a number of potential drawbacks to classroom training. Personality differences between the trainer and the student, for example, can impact the success of any training class. This problem can rarely be anticipated or avoided. Additionally, fellow trainees can dictate the pace of the training, leaving some students behind, and others bored with a pace that is too slow for them.

### *Classroom*

The organization of a classroom, as well as the tools available for learning, all play a role in the effectiveness of training. The layout of a training lab should allow the trainer to interact with the students easily. Students should be able to see any kind of visual aids that are provided. Ideally, the classroom will have a projector for the trainer to use when giving instructions. There should also be adequate workspace, and extra room for taking notes is preferable. An advantage to attending training off-site is the lack of distractions. Phones are not ringing and the students can focus solely on the training.

Keep in mind that the equipment used in an off-site training course might be different from what you use at work. Be prepared to transfer what you learn in the classroom to the technology you use. For example, a training lab might use Microsoft Office XP, while you use Microsoft Office 2000 in your office.

The condition of the training facility is important. Certainly, you do not want to be training on out-of-date or malfunctioning equipment.

### *Content*

A solid technology curriculum has key components that should go unnoticed if they are used well. At the bare minimum, expect the following:

- Different skill levels will be addressed.
- The examples used will be relevant to the work that you do.
- The layout of any training materials will be consistent and easy to read.
- There will be an equal balance between lecture time and hands-on time. (This is especially important in technology training.)
- There should be a glossary, quick guides, and additional resources.

The student should receive a workbook or other material for continued study after the class ends.

Unfortunately, there is not a one-size-fits-all approach when it comes to curriculum. The trainers play an important role here. They must bring the curriculum alive and make it relevant to the students. But as long as the curriculum is solid, half the battle is won. At the very least, this way students leave with enough information to learn more without the trainer.

**c. Compare and contrast various classroom instructional methodologies, including lecture, role-play, case studies, discussions, and practical classroom demonstrations.**

The following is taken from DOE-HDBK-1114-98.

Training programs may be delivered in several ways, including classroom lecture, seminar, discussion, case study, satellite delivery, interactive-video or computer-based training, individual self-study, laboratory or simulator instruction, and OJT observation and supervised practice. The instructional method(s) for a particular training program should be selected based on the type of learning involved and the level of proficiency required.

All necessary training materials should be developed and approved before training is conducted. Training materials promote consistency in training by specifying the method of instruction, learning objectives, schedule and sequence of instruction, and evaluation methods and standards. However, training content may be modified to meet the specific needs and limitations of each class. Policies should be established and control exercised to ensure that training materials are used in a uniform manner by instructors, and that all changes are approved by training supervision or through a defined review process.

*Classroom Instruction*

For classroom instruction, lectures should alternate with demonstrations, discussions, seminars, study sessions, and trainee practice of the material being learned. Training aids should be used to enhance trainee interest. When films and videotapes are used, an instructor should be available to emphasize important points and answer questions. Films and videotapes may supplement, but should not replace, live instruction. Trainees should be encouraged to participate actively in discussions and to ask questions. Lesson assignments should reinforce the desired learning and allow for practice to develop required skills. All written assignments should be corrected and returned promptly to the trainees to derive the maximum benefit. Regular attendance at classroom instruction sessions and proper behavior (punctuality, attentiveness, and performance of assignments) should be required. All missed training sessions should be made up through appropriate study and evaluation.

*Laboratory and Simulator Instruction*

Laboratory and simulator instruction and facility drills and walkthroughs should be preceded by lecture or discussion designed to prepare trainees to derive the maximum benefit from the practical experience. Training aids may be used and personnel encouraged to actively participate and to ask questions. Laboratory and simulator exercises should be structured to provide consistent and repeatable training. Exercises should also be designed to maximize the development and maintenance of necessary job-related knowledge and skills.

### *Case Studies*

The case-study approach has been used effectively in learning from facility and industry experiences. The case-study teaching method promotes the generation of ideas and solutions by the trainees rather than memorization of responses provided by lectures. This method gives trainees an appreciation of events that have actually occurred. Many different case-study methods and settings can be used to enhance diagnostic, communication, and team skills by allowing personnel to apply what they have previously learned to new situations.

### *OJT*

OJT should consist of a systematic process where a trainee observes and practices facility activities. This training should be administered by the trainee's supervisor or another fully qualified individual using training guides that specify the activity and standard of acceptable performance. Qualified individuals should be designated to conduct OJT evaluations and verify satisfactory demonstration of job performance and knowledge requirements by personnel. A schedule should be established for completion of specified portions of this training, and individual qualification progress should be monitored. Individuals, instructors, and evaluators should be alert to and take advantage of unexpected on-the-job training and task performance evaluation opportunities as they occur.

- d. Describe the attributes of an effective classroom instructor, including use of training and media materials, effective speaking, questioning techniques, and subject matter expertise.**

The following is taken from DOE, *Supplemental Guidance for Technical Training Organizational Infrastructure, Responsibilities, and Personnel Qualification*.

Qualification requirements should be established and documented for all facility and subcontract personnel, including occasional/casual instructors who perform training activities. (An occasional or casual trainer is an individual who only instructs several times a year; training is not a part of his/her job description.) These requirements should be based on instructor qualification levels, and should address instructional competence, technical competence, and applicable interpersonal skills. All subcontract instructors, both short-term and long-term, should meet the qualification requirements for the subjects they teach and/or develop.

Instructor trainees who are not fully qualified, as well as occasional instructors, should have limited participation in instructional activities. These individuals should perform assignments under the direct supervision of a qualified instructor or a training supervisor. All instructor trainees who are assigned instructional activities should be formally evaluated by a qualified instructor or a training supervisor.

On a case-by-case basis, determined by testing or experience, an instructor trainee may be granted an exception to specific training program requirements. If an instructor trainee can demonstrate mastery of some/all of the course learning objectives prior to the training, an exception is warranted. Administrative procedures should be developed that allow training management the option of releasing such an individual from portions of a qualification.

### *Instructional Competencies*

A job analysis for a DOE facility's instructors and instructional technologists is not required. However, it is recommended that each facility analyze its work activities to ensure that training-related tasks and their associated knowledge and skills are identified and documented for each instructor qualification level. Analysis results should be compared to the facility's instructor training programs to verify that required knowledge (at the proper cognitive level) and skills are provided in the content of each program. Further, these analyses should be used to establish entry-level requirements (education, training, and work experience) for each instructional qualification level.

The knowledge and skills developed by the facility's instructor training programs should also be compared with the representative instructional competencies. This comparison should help to verify the adequacy of, or identify deficiencies in, the facility's analyses and should also identify generic competencies that may not be needed in facility-specific training programs.

Competencies that are identified as applicable to a specific instructor training program should be written in the form of terminal and enabling learning objectives. In all cases, programs should be in place to develop the specific knowledge and skills required for each instructor's qualification level. It is recommended that if a facility does not conduct its own analysis of training-related activities, the content of its instructor training programs should be initially based on DOE-STD-1001-96, and subsequently refined using a systematic evaluation process.

### *Technical Competencies*

Training staff that perform as instructors in the development, presentation, or evaluation of technical topics should possess technical qualifications consistent with their assignments. Technical qualifications should include theoretical and practical knowledge as well as practical work experience at or above the level that is required of the trainee population. Instructors who initially lack practical work experience should complete portions of operator/technician/craft training programs related to the topics taught. These instructors should thoroughly understand the subject matter and its relationship to overall facility operation.

Each facility should establish written procedures that stipulate what these technical qualifications will be, to whom they apply, and how they may be attained for each instructor qualification level.

### *Interpersonal Skills*

The ability to provide effective training is significantly influenced by the interpersonal skills of the instructor. Interpersonal skills needed by instructors may be identified through observations or interviews with skilled instructors. Trainee feedback on instructor style and delivery may also provide insight to desirable interpersonal skills. Many of these skills are contained in managerial training courses. It is important that these skills are identified and included in the instructor training programs.

The instructor has a pivotal role in affecting the quality of training. The instructor's communication skills can significantly impact instructional effectiveness. Instructors should possess strong listening and speaking skills. Other skills include the ability to listen to questions, to phrase questions that stimulate thought, and to deal effectively with conflict.

The ability to influence trainee behavior is closely related to the instructor's motivational skills and personal example. The demeanor of the instructor is as important to the quality of the instruction as the lesson content and materials. Since trainees tend to model their actions after instructors, it is essential that instructors demonstrate leadership qualities, convey a positive attitude toward training, and promote professionalism in the work environment. Use of these interpersonal skills is the mark of an effective instructor.

- e. Conduct a classroom training session or make a formal presentation to a group of personnel.**
- f. Prepare and administer a technology-based training program.**

Elements e and f are performance-based KSAs. The Qualifying Official will evaluate their completion.

- 7. Technical training personnel shall demonstrate a working-level knowledge of OJT techniques, methodology, and implementation and apply that knowledge to implement and/or evaluate OJT programs in the field.**
  - a. Using DOE-HDBK-1206-98, Guide to Good Practices for On-the-Job Training and DOE-HDBK-1205-97, Guide to Good Practices for the Design, Development, and Implementation of Examinations, describe in detail the following:**
    - **Advantages and disadvantages of OJT**
    - **Development of OJT**
    - **Conduct of OJT**
    - **Evaluation of OJT performance**
    - **Use of open-ended questioning**
    - **Documenting OJT performance**

#### *Advantages and Disadvantages of OJT*

The following is taken from DOE-HDBK-1206-98.

The advantages of OJT are listed below:

- Training takes place in the actual work environment. The trainee is surrounded with the sights, sounds, smells, etc., of the job, so little is left to the trainee's imagination.
- The instructor demonstrates the task at the job site using the same tools and/or equipment the trainee will use to perform the task.
- The instructor can tailor the training to meet the needs of each trainee because the instructor has the option to change the pace, order, depth, and length of instruction to allow the trainee to learn the task.
- The trainee is able to practice the task and gain hands-on experience.

There are also disadvantages to OJT that should be considered:



- The actual job site may not be the best place for training. The equipment at the job site may not be available for the length of time required to conduct OJT. Training may have to take a “back seat” to the requirements for operation. That is, the equipment may simply not be available for training due to operational goals or commitments.
- The cost of OJT can be high. OJT is usually conducted one-on-one, and this method of training and performance testing takes a great deal of time. In some cases, an instructor can train more than one trainee; however, performance tests should always be done one-on-one.
- Certain equipment may be dangerous in the hands of a trainee even under close supervision. (A simulator training setting would be a more desirable setting for tasks that fall in this category.) There is also a chance that a trainee may damage equipment in the process of learning how to operate it.

### *Development of OJT*

The following is taken from DOE-HDBK-1206-98.

The table-top processes for analysis, design, and development described in the DOE-HDBK 1074-95 should be reviewed for applicability when developing or modifying OJT programs. These processes can normally produce equivalent results more efficiently than the more traditional methods that have been used.

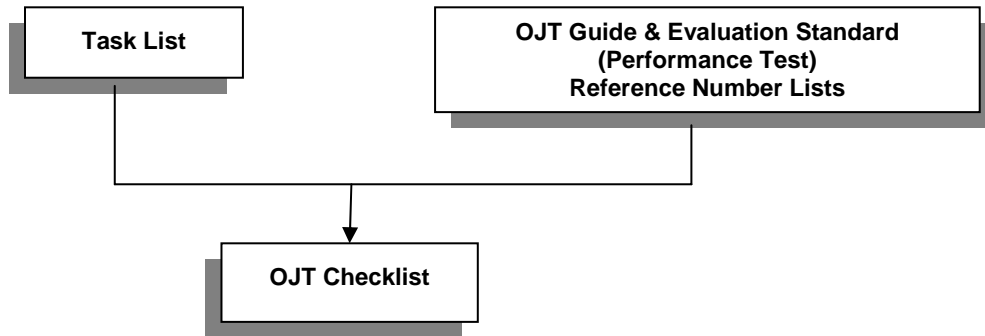
**Analysis phase.** Training requirements can be identified by performing needs analysis, job analysis, and/or task analysis. Analyses form the basis for determining training needs, developing and maintaining valid task lists, and selecting tasks that must be trained on. To facilitate tracking and revisions of training materials on the basis of facility or procedural changes, task lists are entered into systems such as task-to-training matrices. Correctly done, these analyses provide assurance that training is appropriate for the expected performance and identify requirements that serve as the basis for the design and development of OJT programs.

**Design phase.** Design phase activities include writing terminal objectives, selecting appropriate training settings, and developing of TESSs for each task selected for training. It is during the development of the TESSs that the bulk of the tasks are further analyzed, enabling objectives are written, and decisions are made regarding how training will be conducted and evaluated. OJT may be conducted using general instructions and task specific evaluation materials for low-hazard potential facilities or tasks.

**Development phase.** Development phase activities include the writing of training materials such as OJT checklists, qualification standards, and OJT guides. Additional activities include the selection and training of OJT instructors. The specifications generated in the design phase are used to develop an OJT program and all required training materials. Care should be taken to keep OJT materials simple and usable.

OJT checklists (qualification cards) that are specific to an individual OJT program should be developed to document training and performance testing. OJT checklists should be based on knowledge and skills required by the TESSs. The required level(s) of accomplishing performance testing should be specified for each task. While many options exist for the

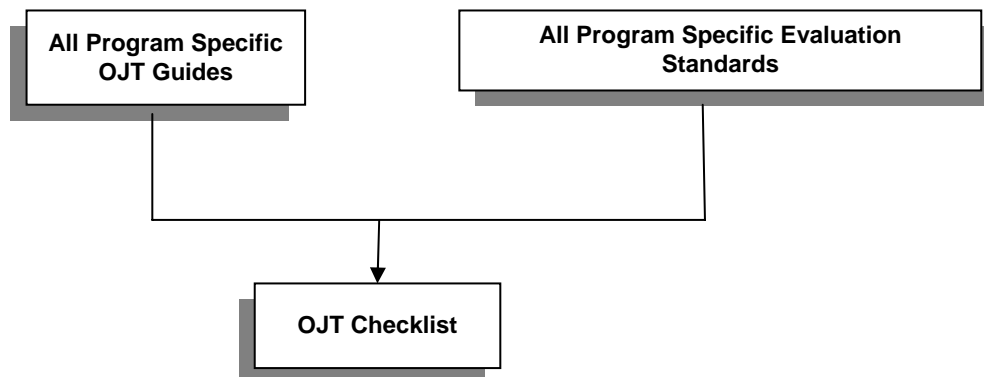
format of an OJT checklist, only two general formats will be discussed. The first, and probably the most common, is simply a list of all the tasks required for qualification and the required level of performance test accomplishment. In this case, the OJT checklist is used as a signature record card to document the performance testing for each task. The completion of training for each task should also be documented on the OJT checklist. An OJT checklist should reference the OJT guides used to conduct the training and the evaluation standards used to conduct the performance tests. If the trainee must be trained and performance tested on a number of tasks to become qualified, this format is usually the best. Figure 3 illustrates the relationship of the elements that make up the most common type of OJT checklist.



*Source: DOE-HDBK-1206-98*

**Figure 3.** Task list-based OJT checklist

A second format used by some facilities includes each task's evaluation standard as a part of the OJT checklist (it may also contain each task's OJT guide). This format, depicted in figure 4, may result in a much larger OJT checklist. If a facility qualifies trainees on a duty area or a task basis, this approach may be workable.



*Source: DOE-HDBK-1206-98*

**Figure 4.** Combination task list/TES OJT checklist

The use of an OJT checklist that has two instructor signatures for each task helps to ensure that OJT is conducted and evaluated as a two-part process. The trainee is taught the task using an OJT guide and is then performance-tested using the evaluation standard.

OJT checklists may contain tasks that have both simulate and perform specified as the acceptable levels of accomplishment. When conducting the OJT and/or the performance test, the OJT instructor should select the highest level of accomplishment that is supported by facility conditions. The OJT guide and the evaluation standard for a task that has multiple levels of accomplishment should be written to support the training and the evaluation at either level of accomplishment.

For tasks with a single level of accomplishment, there may be times that facility conditions do not support performance testing at the specified level of accomplishment. If this is the case, the instructor should inform the OJT program coordinator. The program coordinator may then reschedule the performance test, or, with management's documented concurrence, the specific level of performance test accomplishment may be lowered. This documented concurrence should be attached to, and become a permanent part of, the trainee's OJT checklist.

**Qualification standards.** Qualification standards are documents that contain the knowledge and skill requirements necessary for the successful completion of a training program. A qualification standard should provide explicit guidance to the instructor and to the trainee to aid in the preparation for and the consistent administration of performance tests. A qualification standard should include all program-specific evaluation standards to be used during performance testing. Facilities that qualify employees on a task basis need not develop a qualification standard. In this case, the OJT instructor and the trainee only need the task's evaluation standard.

A qualification standard should be prepared consistent with the program's OJT guides and evaluation standards. It should list the specific procedures and training resource materials required for each task.

This type of information may also be specified on the qualification card/checklist or in other training documents or procedures. The qualification standard may also include reading assignments, self-study requirements, study questions, problem analysis exercises, figures and diagrams, and amplifying information. Qualification standards should not include copies of facility procedures or training manuals/materials. They should instead reference these resources.

Trainees in an OJT program that requires self-study should find the qualification standard a very useful document. It provides them with information on what to study, where this information may be found, and guidance on what they need to learn.

A qualification standard should contain a section that provides a trainee entering an OJT program with information on how that specific program operates, what will be expected of him/her, and how/where to obtain training-related help. It should provide information regarding the use of the OJT checklist and how to use the qualification standard. This section

of the qualification standard should also address the following (if not included in other training documents or procedures):

- Facility restrictions on unsupervised trainee operation of facility equipment/systems
- Guidelines on self-study
- Guidelines on improving listening habits
- Established goals and how trainee progress will be tracked
- How the trainee interacts with the OJT instructor/program coordinator
- How to prepare for performance tests
- Comprehensive testing/evaluation required at the program's completion

OJT guides. Performance-based training programs should require the use of OJT guides (or equivalents) to ensure consistent delivery of training. An OJT guide is a document that outlines instructor and trainee activities, learning objectives, training content, and the resources (equipment, material, etc.) necessary for the consistent conduct of training. The contents of an OJT guide for a specific task should be based on the training standard portion of the TES. An OJT guide should identify trainee prerequisites, learning activities, training equipment, and materials needed for training and specific guidance for their use. OJT guides also provide specific direction to the instructor for guiding the learning process.

Some may question the necessity of OJT guides. However, one of the most frequently asked questions is, "How can we ensure consistent training from one instructor to the next?" One way to ensure this is by the use of the OJT guide. It may be a part of the OJT qualification card/checklist or a stand-alone document. In either case, it should reference the specific task it supports and should be organized and formatted to enhance the one-on-one learning process.

Instructor selection and training. The credibility of a training program depends on the quality of the instructors. OJT instructors should be qualified to deliver OJT and/or conduct performance tests. The selection of OJT instructors is the responsibility of each facility's line and training management; however, first-line supervisor and senior job incumbents are the recommended first choices for OJT instructors. OJT instructors should be trained and qualified in accordance with the guidance in the DOE Guide to Good Practices for Training and Qualification of Instructors.

Several factors should be considered when selecting OJT instructors. OJT instructors should be technically competent. They should have the skills necessary to train and evaluate assigned trainees. Additional factors to be considered when selecting OJT instructors include recognition of responsibilities, professionalism, maturity, judgment, integrity, safety awareness, communication skills, personal standards of performance, and a commitment to quality.

The options normally available for selecting OJT instructors are the first-line supervisors and senior job incumbents or an instructor from the training organization. The supervisors and senior job incumbents are usually SMEs who supervise or perform the job. As such, they have first-hand knowledge of the job. An instructor from training may well be an expert on training, but will typically not be as knowledgeable or proficient in the specifics of the job as an SME. It is usually better to train the supervisor or senior incumbent to be an effective instructor than to train the instructor to be a job expert. When OJT is conducted and evaluated using facility equipment, the instructor must be qualified to perform the task.

OJT instructors should receive instructor training in advance to allow sufficient time to develop instructor competency prior to working with trainees. When instructors have not yet attained the required instructional qualifications or only instruct occasionally, training quality may be maintained through mock training exercises and appropriate supervision and assistance.

All OJT instructors should be given the opportunity to enhance their technical competency and instructional skills. Continuing training that is based on periodic instructor performance evaluations should be provided to all qualified instructors. Instructor evaluations should include direct observation by training and operations supervision during training sessions, and should address technical competency, instructor skills, and overall effectiveness in facilitating the trainee's achievement of the learning objectives. Both announced and unannounced evaluations are appropriate.

### *Conduct of OJT*

During this phase of OJT, the instructor introduces and explains the task to be performed and demonstrates to the trainee how to perform the task. The instructor then supervises the trainee's practice of the task. For high-hazard potential tasks, this phase of the OJT process is separate and distinct from the evaluation phase of OJT. For low-hazard tasks, OJT may be conducted and evaluated simultaneously. This may also be appropriate for category 3 hazard nuclear facilities.

Instructors should use the "Three Ts" of effective training as they conduct OJT. The first "T" is "tell them what you are going to tell them," the second is "tell them," and the third is to "tell them what you told them." Use of the three Ts helps to ensure effective OJT.

The primary instructional method used in the OJT setting is the demonstration-performance method. In this method, the instructor tells and shows the trainee how to perform the task. The shop foreman teaches the apprentice almost entirely by some version of this method, and the flight instructor uses it to teach flying skills. The instructor explains and demonstrates the particular task to the trainee and then coaches while the trainee practices the task. This method is based on the principle that trainees learn best by doing. During the practice, the instructor points out errors and helps the trainee improve techniques or eliminate errors in performance. The trainee is allowed repeated practice to achieve the terminal objective. When the trainee has satisfied the objectives, the instructor concludes the training and documents it on the trainee's OJT checklist.

### *Evaluation of OJT Performance*

During the evaluation phase of OJT, the instructor administers a performance test to assess the trainee's performance against predetermined performance standards. The evaluation phase should be separate and distinct from the training phase. However, OJT for low-hazard tasks may be conducted and evaluated simultaneously. This may also be the case for category 3 hazard nuclear facilities. During the evaluation phase, the instructor tests the trainee. The time for instruction has ended.

Performance testing. A performance test is a hands-on demonstration by the trainee of the knowledge and skills required to perform a task. Performance tests should be given and

evaluated by qualified OJT instructors. The instructor uses an evaluation standard from a TES to determine if the trainee has the knowledge and skills to perform the task. A trainee's knowledge may be assessed prior to, during, or following task completion.

It is suggested that safety-related questions should be asked prior to task performance. A limited number of questions may be asked during the performance test if they will not distract the trainee from the task's performance, with the remaining questions asked following task completion.

The trainee is tested following the completion of training and any additional practice necessary to develop proficiency. Just as in the training phase of OJT, the evaluation phase consists of several distinct steps. To conduct a performance test, the trainee and the instructor should prepare for the test. The instructor should then brief the trainee, conduct the performance test, debrief the trainee, and document the performance test.

#### *Use of Open-Ended Questioning*

Usually it is not enough for employees to only possess the skills to operate a tool, a component, or a system. Knowledge of the underlying theory/principles of operation, interactions with other systems, and actions to perform if the equipment or system doesn't operate properly should also be required. To assess a trainee's knowledge, the instructor must ask questions to verify understanding of the task; however, the instructor should not ask questions to distract the trainee. All questions asked during a performance test should be related to the task's terminal and enabling learning objectives, starting with the easier questions. This technique tends to build confidence and puts the trainee at ease. The instructor may then progress to more thought-provoking questions. The instructor may also ask the trainee to talk through the task as he/she performs it. This technique reduces the number of questions the instructor needs to ask and allows the instructor to stop the trainee before he/she makes a serious mistake. The questions used may be written in the evaluation standard (preferred method) or generated by the instructor during the performance test. Approved questions may be maintained in a question and answer bank and inserted into the evaluation standard prior to conducting a performance test.

Benefits of developing written questions for the instructor to ask as a part of the performance test include standardizing the knowledge assessment portion of the test and minimizing the diversion of the instructor's attention from the trainee's answer (the instructor may be thinking about what to ask next while the trainee is answering the current question). Wrong responses may then go unnoticed, thus reinforcing in the trainee's mind that what he/she said was correct when, in fact, it was not. The questions asked during the performance test should test understanding and judgment as well as factual knowledge.

If the evaluation standard was developed with questions and answers built into it, the instructor should select appropriate questions to spot-check the trainee's knowledge. Questions asked during the test need not be restricted to those stated verbatim in the evaluation standard. The instructor may rephrase or expand them as appropriate. The instructor should also keep in mind that the trainee's answer will usually not be a verbatim answer. The instructor should record on the evaluation standard whether the trainee's response was satisfactory or unsatisfactory, and if unsatisfactory, the given response.

If questions are not included as a part of the evaluation standard, the instructor should ask questions to assess knowledge and record them as previously described.

The instructor has the option of asking several different types of questions during the performance test. This applies equally well to developing questions as part of an evaluation standard or to the instructor who is administering a performance test that was developed without questions. The two most common question types are the open-ended question and the closed-ended question. A good mix of these two types of questions should provide the instructor with enough information to determine whether the trainee has adequate knowledge.

The open-ended question places the burden of conversation on the trainee and gives the instructor time to analyze what the trainee is saying. It reduces the total number of questions asked and is very useful when starting a line of questioning in a new subject area.

#### *Documenting OJT Performance*

If the trainee has satisfactorily performed the task, the OJT checklist should be signed and dated by the instructor. If the task has multiple levels of accomplishment, the instructor should indicate on the OJT checklist the level at which it was accomplished.

#### **b. State and describe the roles and responsibilities of the training organization and line management to ensure effective implementation of an OJT program.**

The following is taken from DOE-HDBK-1206-98.

The ultimate success of any training program requires a strong commitment to training by both line organization management and training management. The concurrence of these organizations regarding goals and content of an OJT program is essential for effective training. However, the facility's line organization has the ultimate responsibility for the proper training of their personnel.

#### **c. Discuss the differences between formal and informal OJT.**

The following is taken from Paradigm Training Systems, Structured OJT Trainer System.

Studies show that employees who are trained with formal OJT require only 20 percent as long to achieve mastery as those in informal OJT. The 80 percent difference is time employees can spend being productive.

Studies also show that formal OJT is only half as expensive as informal OJT in terms of supervisor's time and reduced output and quality.

Informal OJT is unplanned, unevaluated, undocumented, and unsupportive of quality and International Organization for Standardization programs.

Formal OJT is planned, prioritized, and scheduled. Trainers are trained; trainees learn quickly and correctly, and are evaluated; and the results are documented, so quality and International Organization for Standardization programs are supported.

Formal OJT can support your classroom training and internet training by providing follow-up on-the-job practice to ensure real competence.

Finally, formal OJT is faster, better, and cheaper than informal OJT.

**d. Describe the role of the trainer, the evaluator, and the trainee in the OJT process.**

The following is taken from DOE-HDBK-1206-98.

The primary instructional method used in the OJT setting is the demonstration-performance method. In this method, the instructor (trainer) tells and shows the trainee how to perform the task. The instructor explains and demonstrates the particular task to the trainee and then coaches while the trainee practices the task. This method is based on the principle that trainees learn best by doing. During the practice the instructor points out errors and helps the trainee improve techniques or eliminate errors in performance. The trainee is allowed repeated practice to achieve the terminal objective. When the trainee has satisfied the objectives, the instructor concludes the training and documents it on the trainee's OJT checklist.

During the evaluation phase of OJT the evaluator administers a performance test to assess the trainee's performance against predetermined performance standards. The evaluation phase should be separate and distinct from the training phase. However, OJT for low-hazard tasks may be conducted and evaluated simultaneously. This may also be the case for category 3 hazard nuclear facilities.

**e. List and discuss the process steps that OJT instructors use to help trainees learn on the job.**

The following is taken from DOE-HDBK-1206-98.

The process steps that OJT instructors use to help trainees learn on the job are

- preparation,
- introduction,
- explanation,
- demonstration,
- practice, and
- conclusion.

The following paragraphs provide a brief description of each of these steps.

*Preparation*

Instructors should adequately prepare prior to conducting OJT to ensure consistent and effective training. A major portion of preparation should be a review of the OJT guide (or equivalent). This review should concentrate on the equipment and/or tools required, expected trainee preparations, reference materials, and safety precautions, and may include a review of the factors that influence trainee learning and motivation. The instructor should review the procedures referenced by the OJT guide, prepare the job site, and ensure that all necessary



tools, materials, and procedures are available. The instructor should also ensure that sufficient time for the training has been scheduled.

### *Introduction*

The instructor should put the trainee at ease. It is natural for a trainee to be somewhat nervous at first, especially if this is the first contact with the instructor. Time spent putting the trainee at ease will normally be time well spent. A relaxed trainee will be more receptive to the OJT process. The instructor should motivate or arouse the trainee's interest in the training session. An adult likes to see a direct link between his/her job and the skills and knowledge presented during the training. To help to establish this link, the trainee needs answers to the following questions:

- What's in it for me?
- Why do I need to learn this?
- When will I use this information?
- How will I use this information?

The trainee should understand the terminal and enabling learning objectives. The instructor should state and discuss the objectives with the trainee to ensure that the trainee understands the required performance, how well it should be performed, and under what conditions.

The instructor should provide the trainee with the first "T" of effective training — "tell them what you are going to tell them." The instructor should present an overview of the task that includes not only what will be learned, but how it will be presented. The overview should be brief and stress safety measures and compliance to procedures. This process may also help to relate this training to previous or future training. The instructor should make sure the trainee understands that he/she can ask questions anytime during the training.

The instructor should continue to stress safety while establishing the ground rules regarding how he/she intends to conduct the training. Explain under what circumstances the evolution will be interrupted (e.g., to demonstrate if needed) and under what circumstances the evolution will be stopped (e.g., if personnel or equipment safety concerns arise). The instructor should stress that facility procedures (administrative, operations, maintenance, lockout and tagout, radiological, etc.) must be adhered to at all times.

The instructor should determine what the trainee already knows about the particular job or task. The instructor should then tailor the training based on a combination of the trainee's experience, knowledge, and training completed to date. By briefly reviewing what the trainee knows and then progressing to new material, the risk of losing the trainee's attention will be minimized.

The instructor should minimize interruptions during the training process. The presence of co-workers at the training site may be a problem because the trainee needs to be able to practice, make errors, and receive corrective instruction without personal embarrassment.

Although elimination of all co-workers from the vicinity of the training is difficult or impossible, some degree of privacy is needed.

The last step in the introduction is to express confidence that the trainee will learn to perform the task quickly and well. The goal is for the trainee to begin the training with a feeling of confidence and a desire to meet the challenge.

### *Explanation*

For a simple task, the instructor may combine the explanation and demonstration steps of OJT. For a complicated or hazardous task, however, it is usually better if the instructor separates these two steps.

The instructor tells the trainee how to perform the task — the second “T” of effective training. The instructor should clearly describe the action(s) the trainee is expected to perform. An important consideration in this step is the language used. Instructors should speak on a level the trainee understands and fully explain technical terms.

The instructor should stress key points and critical steps during the explanation of the task. This helps the trainee differentiate between the important (critical) and the not-so-important information. Full use should be made of being at the job site to explain the task and bring to the trainee’s attention any cues and/or stimuli related to the task. The instructor should explain why and in what order procedural steps or task elements are done to reinforce learning and stress safety by his/her words and actions.

An effective explanation requires two-way communication between the instructor and the trainee. The instructor should ask the trainee questions to verify comprehension and should be patient and willing to explain something as many times as necessary. The instructor should answer any questions the trainee asks.

Most skills lend themselves to a sequential pattern where the instructor explains the skill in the same order in which it is performed. When the instructor can relate material to what a trainee already knows, the known-to-unknown strategy may be used effectively. When teaching more than one skill, the simple-to-complex strategy works well. By starting with the simplest skill, trainees build confidence and are less likely to become frustrated when faced with more complex skills. The instructor should not describe short cuts or unapproved alternative methods of performing a task. The instructor should not try to impress the trainee with his/her knowledge, because training should be trainee centered.

### *Demonstration*

During the demonstration step, the instructor shows and explains to the trainee how to perform the task. The instructor may demonstrate the complete task and then require the trainee to practice, or they may perform the demonstration and practice steps together on an element-by-element basis. A well-written OJT guide (or equivalent) should provide the necessary guidance to the instructor regarding the most effective techniques to use.

It is important that the instructor demonstrate the skill correctly and safely the first time. If demonstrated incorrectly, the instructor’s credibility is reduced and the trainee will have to unlearn the incorrectly presented material before he/she can learn it correctly. The instructor should stress safety and compliance with facility procedures. An effective way to do this is by his/her own personal actions. Since the trainee generally imitates the instructor’s performance, the instructor should demonstrate the task exactly the way it should be

performed. The instructor should ask the trainee frequent questions and explain or demonstrate task elements again as necessary. The instructor should proceed slowly and continue the demonstration only after it is clear that the trainee understands.

### *Practice*

The instructor should closely supervise the trainee's initial practice to ensure safe and correct task performance. An effective method of conducting the practice step is to have the trainee talk through the key points and demonstrate the main steps of the task. During the practice session, the instructor should ask the trainee questions regarding what is being done, why it is done, and what indications to look for. The trainee should practice at his/her own pace without unnecessary interruption or too much instructor assistance. As the trainee gains proficiency, the instructor should reduce or fade his/her coaching. However, the instructor should never hesitate to stop the trainee if a mistake can be prevented or has been made. The instructor should correct improper actions promptly and without belittling the individual. The trainee will usually know what he/she did wrong, and very little correction should be necessary. The instructor should be patient and provide positive comments on the trainee's initial efforts.

Sufficient time should be scheduled to allow for trainee practice. Depending on the difficulty a trainee is having performing a task, the instructor may have to schedule additional training and practice at a later date. The time to identify and correct errors is during the training rather than during the performance test.

The OJT guide (or equivalent) should specify the degree of supervision that is required when the trainee practices under supervision. Facility procedures and the hazard or complexity of the task should be the overriding factor in this requirement. In both of the following cases the instructor supervises the trainee, but the degree of supervision is different:

- **Controlled.** The instructor closely supervises the trainee. The trainee works at his/her own pace, but the instructor is always ready to stop him/her to prevent or correct mistakes.
- **Independent.** The instructor allows the trainee to practice the task at his/her own pace following the demonstration. This method has limited usefulness for facility operators, but may work quite well in a shop or laboratory environment. The instructor closely supervises the trainee the first time he/she practices the task and then allows the trainee to practice independently, periodically checking and coaching as necessary.

Regardless of the method used, the end result should be sufficient trainee practice to develop proficiency in task performance (i.e., performance satisfies the learning objectives).

### *Conclusion*

The conclusion of the training phase of OJT usually consists of three important elements. The first element is a summary of the training and is the last "T" of effective training — "tell them what you told them." The summary consists of a review of the learning objectives and the task steps. The instructor should make positive comments and praise what the trainee did well.

This should be done even during review of an area in which the trainee had difficulty. However, it is equally important to discuss the areas in which the trainee had difficulty, because suggestions for ways to improve specific difficulties are also important.

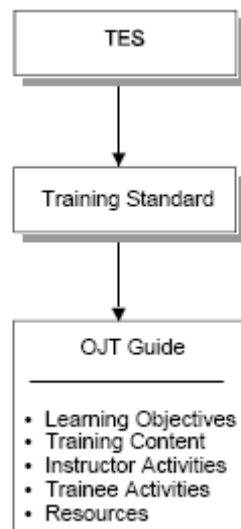
The second element is to provide additional motivation for the trainee. Reinforce how this training will help him/her perform on the job, and discuss how it relates to previous and future training.

The last element is to document the training. Facility training procedures should specify how the instructor documents completion of training. One method is to document the training on the individual's OJT checklist.

**f. Describe the format and content of a typical OJT training guide and job performance measure or evaluation standard, including a discussion of the essential elements of each.**

The following is taken from DOE-HDBK-1206-98.

Performance-based training programs should require the use of OJT guides (or equivalents) to ensure consistent delivery of training. An OJT guide is a document that outlines instructor and trainee activities, learning objectives, training content, and the resources (equipment, material, etc.) necessary for the consistent conduct of training. The contents of an OJT guide for a specific task should be based on the training standard portion of the TES. An OJT guide should identify trainee prerequisites, learning activities, training equipment, and materials needed for training and specific guidance for their use. OJT guides also provide specific direction to the instructor for guiding the learning process. The relationship of an OJT guide to the TES and the OJT guide's content is depicted in figure 5.



*Source:* DOE-HDBK-1206-98

**Figure 5.** OJT guide

OJT guides should not contain copies of facility procedures. Rather, they should reference the appropriate procedures and provide the instructor with task-specific guidance which enhances the learning process. It should not include generic instructions that would be more appropriate in a training procedure or other type of guidance document. This practice helps ensure that the system/facility is operated only with approved procedures (which adds realism to the training), rather than with training materials, and will minimize revisions to the OJT guide as facility procedures are revised.

OJT guides should be prepared with the assistance of the OJT instructor serving as the SME. They should be reviewed by an additional SME who was not directly involved in their development, and should be approved prior to use by supervisory members of the training staff and the management of the work group for which the training was developed.

There are numerous factors which can have a significant influence on a trainee's learning and motivation during the OJT process. Instructors or training material designers/developers should use these factors as they develop OJT guides.

There are many OJT guide formats that could be successfully used for OJT. OJT guides normally consist of a cover page, a body, and a conclusion. It should be noted that much of this information may be included in the qualification card/checklist or other appropriate training procedures or guidance documents. The cover page should provide the instructor with the following information:

- Task title, number, and estimated time to complete the training
- Tools, materials, equipment, and references required
- Safety precautions and procedural limitations
- Reference to relevant facility procedures, facility conditions, and whose permission is required
- Terminal and enabling objectives
- Trainee prerequisites
- Notes to the instructor — guidance/suggestions
- OJT guide review and approval signature(s)

The body is the outline for the instructional process and includes the following major sections:

- Introduction
- Explanation
- Demonstration
- Practice under supervision

The conclusion includes the following elements:

- Summary
- Additional motivation
- Documentation of training

**g. List and discuss the key elements and components of a valid and reliable practical evaluation process for evaluating trainee knowledge and skill upon completion of OJT.**

The following is taken from DOE-HDBK-1206-98.

During the evaluation phase of OJT, the instructor (evaluator) administers a performance test to assess the trainee's performance against predetermined performance standards. The evaluation phase should be separate and distinct from the training phase. However, OJT for low-hazard tasks may be conducted and evaluated simultaneously. This may also be the case for hazard category 3 nuclear facilities. During the evaluation phase, the instructor tests the trainee.

*Performance Testing*

A performance test is a hands-on demonstration by the trainee of the knowledge and skills required to perform a task. Performance tests should be given and evaluated by qualified OJT instructors. The instructor uses an evaluation standard from a TES to determine if the trainee has the knowledge and skills to perform the task. A trainee's knowledge may be assessed prior to, during, or following task completion.

It is suggested that safety-related questions should be asked prior to task performance. A limited number of questions may be asked during the performance test if they will not distract the trainee from the task's performance, with the remaining questions asked following task completion.

The trainee is tested following the completion of training and any additional practice necessary to develop proficiency. Just as in the training phase of OJT, the evaluation phase consists of several distinct steps. To conduct a performance test, the trainee and the instructor should prepare for the test. The instructor should then brief the trainee, conduct the performance test, debrief the trainee, and document the performance test.

*Preparing for a Performance Test*

**Trainee preparation.** The trainee should review the evaluation standard and the OJT checklist to determine the required level of accomplishment. If there has been a significant time lag between the completion of training and the scheduled performance test, the trainee should study and/or practice the task under an OJT instructor's supervision to help refresh his/her skills. The trainee should confirm the scheduled evaluation time, review safety requirements, and obtain any necessary safety equipment.

**Instructor preparation.** The instructor should confirm scheduled evaluation time with the trainee and verify completion of all prerequisite training. The instructor should prepare for the performance test by reviewing the materials that will be used (the OJT checklist, the evaluation standard for the task, and the procedure). If time permits, the instructor may want to walk through the task to ensure he/she is current on task specifics.

The instructor should ensure that required facilities, equipment, personnel, materials, etc., will be available at the scheduled time, and that facility operations will support and allow the level of accomplishment specified for the performance test.

### *Briefing the Trainee*

Prior to conducting a performance test, the instructor should provide the trainee with an overview of the performance testing process and explicit instructions regarding the task to be tested. That is, the instructor should provide clear and complete instructions as to what the trainee is/is not allowed to do and explain under what circumstances he/she will stop the trainee (such as in case of danger to personnel or equipment).

The instructor should review the evaluation standard with the trainee and explain the standards of acceptable performance. The instructor should tell the trainee that any answer or action that would place personnel, the facility, or system in danger is an immediate failure of the performance test regardless of the acceptability of other responses.

### *Conducting the Performance Test*

A performance test is not an instructional process. Its purpose is to evaluate the trainee's skills and knowledge. The instructor should not coach or prompt the trainee by giving hints, by asking leading questions, or by his/her actions. If a task requires the trainee to go to a location, the instructor should not lead the way. If the evaluation standard references a procedure, that procedure should be available to the trainee during the test but should not be handed to the trainee by the instructor. Part of the performance test is to assess the trainee's use of procedures and understanding of their importance.

With most tasks, the instructor should be able to determine if the trainee is performing the task correctly by observing and comparing the trainee's actions to the evaluation standard and the procedure. The instructor should evaluate the trainee's ability to

- obtain the needed reference material and tools without difficulty;
- use the references and tools correctly and in the proper sequence;
- observe applicable facility safety rules when performing the task;
- manipulate the equipment in a deliberate and timely manner; and
- recognize equipment status (such as, does he/she recognize when a valve is open or a pump is running).

Usually it is not enough for employees to only possess the skills to operate a tool, a component, or a system. Knowledge of the underlying theory/principles of operation, interactions with other systems, and actions to perform if the equipment or system doesn't operate properly should also be required. To assess a trainee's knowledge, the instructor must ask questions to verify understanding of the task; however, the instructor should not ask questions to distract the trainee. All questions asked during a performance test should be related to the task's terminal and enabling learning objectives, starting with the easier questions. This technique tends to build confidence and puts the trainee at ease. The instructor may then progress to more thought-provoking questions. The instructor may also ask the trainee to talk through the task as he/she performs it. This technique reduces the number of questions the instructor needs to ask and allows the instructor to stop the trainee before he/she makes a serious mistake. The questions used may be written in the evaluation standard (preferred method) or generated by the instructor during the performance test. Approved questions may be maintained in a question and answer bank and inserted into the evaluation standard prior to conducting a performance test.

Benefits of developing written questions for the instructor to ask as a part of the performance test include standardizing the knowledge assessment portion of the test and minimizing the diversion of the instructor's attention from the trainee's answer (the instructor may be thinking about what to ask next while the trainee is answering the current question). Wrong responses may then go unnoticed, thus reinforcing in the trainee's mind that what he/she said was correct when, in fact, it was not. The questions asked during the performance test should test understanding and judgment as well as factual knowledge.

If the evaluation standard was developed with questions and answers built into it, the instructor should select appropriate questions to spot-check the trainee's knowledge. Questions asked during the test need not be restricted to those stated verbatim in the evaluation standard. The instructor may rephrase or expand them as appropriate. The instructor should also keep in mind that the trainee's answer will usually not be a verbatim answer. The instructor should record on the evaluation standard whether the trainee's response was satisfactory or unsatisfactory, and if unsatisfactory, the given response.

At the completion of a performance test, the instructor must make a judgment call. Compared to the evaluation standard, did the trainee have satisfactory knowledge and skills or not? The use of a detailed evaluation standard that includes questions and answers will reduce the subjectivity of this decision. There are many possible outcomes of a performance test. The following three are generic examples:

- The trainee demonstrated satisfactory skills and knowledge, with no weak points. The instructor signs the trainee's OJT checklist.
- The trainee demonstrated satisfactory skills and knowledge, but lacked information on some minor details. The instructor may cover those details during the debrief and sign the trainee's OJT checklist.
- The trainee's performance was unsatisfactory. The trainee lacked necessary skills or showed a significant lack of knowledge and understanding. The instructor should counsel the trainee as to the remediation required and what to practice or study, and should request the OJT program coordinator to reschedule additional training and another evaluation. The instructor should also discuss the trainee's performance with the program coordinator.

### *Debriefing the Trainee*

At the completion of a performance test, the instructor should conduct a detailed review of the trainee's performance. The instructor should tell the trainee if he/she passed or failed the test.

The instructor should make positive comments while reviewing the performance test results. Based on the outcome of the test, the instructor should either discuss the knowledge items missed with the trainee or require the trainee to find the correct answers.

### *Documenting Performance Test Completion*

If the trainee has satisfactorily performed the task, the OJT checklist should be signed and dated by the instructor. If the task has multiple levels of accomplishment, the instructor should indicate on the OJT checklist the level at which it was accomplished.



- h. Prepare and administer an OJT session and corresponding performance evaluation for an assigned training program or course.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion.

- 8. Technical training personnel shall demonstrate a working-level knowledge of oral, written, and performance evaluation techniques and methodologies, and other techniques used to evaluate the effectiveness of a training program.**
- a. Using DOE-HDBK-1078-94, DOE-HDBK-1204-97, Guide to Good Practices for the Development of Test Items, and DOE-HDBK-1205-97, Guide to Good Practices for the Design, Development, and Implementation of Examinations, describe in detail the following:**
- **Purpose of testing**
  - **Correlation between tests and learning objectives**
  - **Types of test item formats**
  - **Selection of test item formats**
  - **Use of test item statistics to evaluate the quality (validity and reliability) of test items and training material**
  - **Use and control of examination banks**

#### *Purpose of Testing*

The following is taken from DOE-HDBK-1205-97.

There are several reasons for using tests in job and training environments. These include:

- trainee assessment,
- trainee selection and placement,
- trainee motivation,
- instructional improvement,
- program evaluation, and
- testing as a teaching instrument.

These reasons each have their benefits and are applicable to the development and conduct of DOE training programs. In a program based on the SAT, tests are normally designed and developed for the purpose of trainee assessment. However, the other reasons listed can also be achieved by analyzing and interpreting the test results.

#### *Correlation Between Tests and Learning Objectives*

The following is taken from DOE-HDBK-1205-97.

When designing a test, the purpose of the test should always be to evaluate which learning objectives have been met and therefore the knowledge acquired or which tasks or partial tasks a trainee is qualified to perform. However, the results of the test may be used to tell us more than that when combined with other evaluation results. For example, results may indicate that:

- the trainee qualifies for advanced placement or exception;
- the material on a particular subject needs upgrading; or
- a particular test question is poorly worded.

When properly developed and conducted, testing should provide a valid and reliable indicator of trainee performance. Whether written, oral, or performance, tests provide the most complete and efficient method of collecting and documenting data on trainee performance. Observation interviews and other applied research methods can also offer a significant amount of information.

#### *Types of Test Item Formats*

The following is taken from DOE-HDBK-1204-97.

There are different formats of written test items (e.g., short-answer, multiple-choice, matching, and essay).

Traditionally, test items that require the trainee to supply an answer (e.g., short-answer, essay) have been considered subjective; test items requiring the trainee to select an answer (e.g., multiple-choice, matching) have been considered objective. If graders require subject matter expertise to interpret the answers of test takers, the test item is considered subjective. If the examination can be scored without having to interpret the answer (e.g., machine scored), it is considered objective. An objective test item is defined here as one in which: (a) there is only one correct answer, and (b) all qualified graders would agree on the amount of credit allowed for any given trainee's answer.

#### *Selection of Test Item Formats*

The following is taken from DOE-HDBK-1205-97.

There is no single test format for all situations. A format appropriate in one environment may be less appropriate in another. Each format has its advantages and disadvantages. Test quality depends on the quality of the learning objectives and the consistency between these objectives and the test items. The test developer may consider the following factors when developing tests.

#### *Facilities Available*

If time permits, the actual job environment may be used to perform the test. Ideally, training environments are divided into classroom, laboratory, simulator, and OJT, with each environment using the most appropriate test format.

#### *Number of Trainees*

The number of trainees that take a test can impact on the format chosen for the test. A key advantage of certain formats is quick scoring. If a test is used for a large number of people, this may be the best choice. However, quality should never be sacrificed for quantity.

#### *Time*

Essay tests generally require more time to administer and score. Essay tests may require an hour to administer four questions, while four multiple choice questions can typically be completed in a few minutes. The length of a written test should not exceed the number of test items which could be answered in two hours by the average trainee. This may require assembling several tests for a given instructional area. Time is also a factor in the administration of performance tests. It can easily take several hours to set up and administer a

performance test on a simulator or in an on-the-job location. Before tests can be developed, the appropriate test format should be selected. There are three basic formats:

- Written tests
- Oral question tests
- Performance tests

#### *Use of Test Item Statistics to Evaluate the Quality (Validity and Reliability) of Test Items and Training Material*

The following is taken from DOE-HDBK-1205-97.

Because tests are used to qualify trainees to do a job or task, it is important that they are developed properly. If tests are constructed systematically and administered correctly, they will have a high degree of reliability. The quality and effectiveness of tests should be continuously monitored and improved where necessary. Analysis of test results provides important input to the quality and effectiveness of tests. Whereas most instructors and test developers are not required to perform complicated statistical analyses, an understanding of some basic concepts is beneficial in interpreting and refining the testing process.

#### *Reliability*

Reliability is functionally defined as the consistency between two separate measurements of the same thing. If a test gives perfectly consistent results, it would be perfectly reliable. Reliability is generally not a problem with performance tests as long as conditions in the evaluation situation remain constant. Reliability can be a problem with written tests because test item construction can be difficult. Reliability can be affected by ambiguous test items, multiple correct answers, typographic errors, adverse testing conditions, interruptions, limited time, and complicated answer sheets. Trainee readiness and scoring errors also affect test reliability.

#### *Validity*

A valid test must measure exactly what it was intended to measure. A test can be reliable but not valid, or valid but not reliable. A paper and pencil test can be reliable in measuring knowledge of certain welding fundamentals but not valid for measuring welding skill. Establishing the validity of tests can be a complicated and time consuming process. Validity can be improved by:

- ensuring a good analysis of tasks has been conducted.
- ensuring that knowledge and skill requirements have been identified.
- ensuring that learning objectives for both knowledge and skills are based on task requirements.
- identifying type of performance dictated by objectives (cognitive, psychomotor, affective).
- ensuring action verbs used in objectives measure what they were intended to measure.
- designing test specifications to ensure that objectives are covered adequately.
- discussing the test with SMEs, supervisors, and training specialists.
- piloting the test or sample test items with SMEs and trainees.
- comparing test results to actual job performance.
- ensuring that the test and test items are changed to be consistent with revised job requirements.

### Content Validity

Content validity is the simplest method to assess whether a test is valid. Establish content validity by comparing the test items to the learning objectives. No statistical calculations are used to establish content validity. If SMEs agree that the test items measure their respective learning objectives, the test can be considered valid. The usefulness of content validity is subject to the quality of the analysis and the subsequent learning objectives as well as the thoroughness of the SME review of the test items.

### Concurrent Validity

Concurrent validity of a test is when one test compares favorably with another, already validated test. If there is already a valid measure (i.e., nationally recognized entrance exam) of what is to be tested, determine the degree of association between the results of the preestablished test and the test to be validated. To the extent that they are related, there is an established level of concurrent validity. A statistical analysis is required to establish a level of concurrent validity. Information on statistical analysis to determine concurrent validity can be found in several commercially available textbooks on statistics.

### Predictive Validity

Predictive validity is when trainee scores on one test can be used to predict success on a second test after a given time interval. Establishing predictive validity is accomplished in a similar manner as establishing concurrent validity. Statistical analysis is used to determine predictive validity as long as both tests are scored on a pass or fail basis and the tests are separated by a substantial period of time.

### *Use and Control of Examination Banks*

The following is taken from DOE-HDBK-1205-97.

Facility training departments should develop and maintain test banks. These banks should consist of previously used tests, answer keys, and test items. Not only do these test banks save a great deal of time, but the resulting tests are significantly improved because of any modifications made following the use of each test. Training programs should include such a test bank and instructors should collect test analysis information each time a test is used. Since facility training organizations may provide training by program area using several instructors, it is important that the test bank concept be applied at the program level. In this way, the size, scope, and uniformity of the testing process will be improved.

The widespread use of computers and data-base software has added significantly to the capabilities and flexibility of such systems. For example, multiple versions of a test may be produced to increase test security during administration. There is a large amount of written test generation and records maintenance software systems available to increase the ease and efficiency of test development and administration. These systems provide an effective tool for test item evaluation and improvement.

### Test Bank Establishment Considerations

The following should be considered when establishing test banks:

- The scope of the bank

- Effective security controls for computerized test banks
- An ongoing program for test and test item analysis
- The use of machine-scored answer sheets as appropriate
- Clear guidelines and procedures
- A test outline or test specifications

**b. List and discuss the key elements and components of a valid and reliable testing program to evaluate trainee knowledge during, or upon completion of classroom training.**

The following is taken from DOE-HDBK-1204-97.

Following are basic principles that apply across all test item formats:

- Ensure that the concept is relevant to the ability to perform the job.
- State the test item concisely.
- Choose the higher cognitive level.
- Make sure the test item matches the learning objective.
- Omit unnecessarily difficult or irrelevant test items.
- Limit the test item to only one concept or topic.
- Avoid copying text directly from reference materials.
- Avoid backwards logic test items.
- Place the easier test items at the beginning of each section.
- The test item should discriminate between those who have mastered the objective and those who have not.

Ensure that the concept being measured has a direct relationship to the ability to perform the job. The construction of the test item should clearly reflect the enabling objective. Word the test item so that it would be considered valid and reasonable to other SMEs using the same reference materials.

State the test item as concisely as possible, but provide all necessary information. The test item should be clear, grammatically correct, and free of clues to the correct answer. It should be written at a reading level appropriate for the trainee. Often the individuals who develop a test item assume that certain conditions are inherent in the question when, in fact, they are not. It is important to have others review your test items to ensure that all necessary information is included, and that all excess information is deleted. You should ask yourself: Will the trainees clearly know what they are expected to do? Do they have all the information they need to answer the test item? Does answering the test item depend on certain assumptions that must be stated?

When there is a choice between two cognitive levels, write your test item to reflect the higher level. Learning objectives and test items should be written to reflect the level of cognitive domain that is most appropriate. Examinations should consist of higher-level cognitive test items.

Make sure that the test item matches the learning objective. It is very easy to end up with a test item that tests a relatively trivial aspect of an important learning objective. When reviewing your draft test item, ask yourself whether it is likely that someone could answer the test item correctly and still not meet the objective or perform the tasks.

Omit test items that are irrelevant. When reviewing your draft test item, ask yourself: could someone do the job safely and effectively without being able to answer the test item? If so, is it because the content is inappropriate, the wording is unclear, or the level of understanding is too great?

Limit the test item to one concept or topic, unless a synthesis of concepts is being tested. Each individual test item should be reserved for testing one topic, and that topic, as well as the intent of the test item, should be clear to both examiner and trainee. There is a common misconception that testing for multiple topics in one test item is a time-efficient way to examine. Test items containing a variety of topics only serve to confuse the trainee about the purpose of the test item and, therefore, what is expected in terms of a correct response.

Avoid copying text directly from training or other reference material. Test items written in this way generally encourage rote memorization. Further, copying from reference material can cause confusion in test items because the material lifted often draws its meaning (and importance) from its surrounding context. Therefore, important assumptions or conditions stated elsewhere in the material are often omitted from the test item.

Avoid backwards logic test items, i.e., those test items that ask what should be provided in the test item, and provide what should be required in the trainee's response. It is important to test topics in a way consistent with how the topic should be remembered and used. For example, consider the following test item:

If it takes 12.5 cubic feet of concrete to build a square loading pad 6 inches thick, what is the length of one side of the pad?

This test item gives the test takers information they should be asked to calculate, while it requires them to provide information that would be supplied in an actual work situation. In constructing your test items, make sure that you include information that trainees would typically have or have access to, and require responses that reflect the decisions, or calculations, or other information they would typically have to supply.

Place the easier test items at the beginning of each section. These test items help trainees gain composure and confidence. However, this is not to say that extremely easy test items should be included in the exam for the sole sake of relieving trainee tension.

Finally, a test item must be worded so that it discriminates between those who have mastered the objective and those who have not. A well-written test item should parallel the objective that it is testing.

**c. Prepare and administer a training evaluation for an assigned training program or course.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion.

- d. Using DOE-HDBK-1078-94 and DOE-HDBK-1201-97, Guide to Good Practices: Evaluation Instrument Examples, describe the methods used to monitor the effectiveness of training, including:**
- Operating experience

- **Supervisor feedback**
- **Trainee feedback**

The following descriptions are taken from DOE-HDBK-1078-94.

### *Operating Experience*

Facility operating, maintenance, and industrial safety experiences should be monitored to identify employee performance problems caused by improper training. Facility events and industrial accident reports can identify tasks for which inadequate training may be contributing to equipment damage, excessive unavailability, unscheduled maintenance, rework, unsafe practices, or lack of adherence to approved procedures. This information should be supplemented with interviews. Training personnel should monitor the frequency of personnel errors, and review accident and event reports for training implications using the following questions.

- Did the employee fail to follow prescribed procedures?
- Did the employee improperly diagnose the situation?
- Was the employee misinformed or unaware of the correct procedure?
- What was the specific sequence of events?
- Has this problem or a similar problem occurred in the past?
- Was an individual injured?
- Was equipment damaged?
- Was a significant amount of work time lost?
- Was a technical safety requirement or standard violated?
- Does the report describe a new or unusual situation?
- Was the employee newly assigned to this position?
- Are job performance standards different from those used in training?

### *Supervisor and Trainee Feedback*

Trainee, supervisor, and instructor feedback is gathered to identify program strengths and weaknesses. Instructor and trainee critiques completed during implementation should be included in this data. This feedback can be gathered using checklists, numerical rating scales, questionnaires, and interviews. Regardless of the material, process, or program being evaluated, there are general principles that should be followed to construct an evaluation instrument.

- 9. Technical training personnel shall demonstrate a working-level knowledge of the requirements and attributes associated with an effective records management system.**
  - a. Describe the difference between individual training records and program training records.**

The following is taken from DOE/NE-0102T.

The documentation of training includes preparing, distributing, storing, controlling, and retrieving records and reports that address the training program and trainee participation. These records and reports assist management in monitoring the effectiveness of the training

program. They also provide a historical reference of changes that have occurred within a program due to evaluations. When documenting a training program, the training program and trainee records are maintained and reports are prepared, as indicated by the recommended steps below.

#### *Maintain Training Program Records*

Training program records should be maintained to permit review of content, schedules, and current and past program results. These records should be classified according to type and retention period. They should be located, organized, and indexed for ease of retrieval.

Training program records should include the following:

- Most recent job and task analysis data used in training program development
- Course schedules
- Lesson plans and tests
- Trainee attendance summaries (name, course, dates, and test results)
- Instructor evaluations
- Reports of program audits and evaluations

#### *Maintain Trainee Records*

Records of the training and qualification of facility employees should be maintained. Records should be current and organized to permit efficient but controlled retrieval. A trainee's record should contain the individual's training history and the identification of required training that has not been completed. Specifically, trainee records should include the following:

- A summary of the individual's education, training, experience, and qualifications at the time of hire
- A summary sheet indicating the individual's current and previous positions with the company, training received, qualifications achieved, and continuing training required
- A record of training completed, including course titles, attendance dates, test performance, and certifications of successful course completion
- A record of training attended but not successfully completed, including course titles, attendance dates, and test performance evaluations
- A record of waivers or exceptions granted, including course titles and statements of justification

#### **b. Describe the difference between training records and qualification records.**

The following is taken from DOE-HDBK-1001-96.

Auditable records of each individual's participation and performance in or exception(s) granted from the training program(s) (instructional and technical as appropriate) should be maintained. Individual training records should include the following (as appropriate):

- Verified education, experience, employment history, and most recent health evaluation summary
- Training programs completed and qualification(s) achieved
- Latest completed checklists, graded written examinations (with answers corrected as necessary or examination keys), and operational evaluations used for qualification (this requires controlled access to training records to maintain examination security)



- Lists of questions asked and the examiner's overall evaluation of responses on oral examinations
- Correspondence relating to exceptions granted to training requirements, including justification and approval
- Records of qualification for one-time-only special tests or operations
- Attendance records for required training courses or sessions

A historical record that documents the initial qualification for each position qualified should be maintained as part of individual training records. For example, if an instructor is initially qualified in 1986, the record should contain the date and name of the qualification. If more than one qualification is achieved and maintained, the individual training record should contain documentation to that effect.

Completed examinations, checklists, operational evaluations, etc., for presently held technical qualification(s) should be maintained in the record. (Some facilities may prefer to maintain a separate file of completed examinations with answer keys for each individual.) When an individual holds qualification in multiple positions, records that support current qualifications for each position should be maintained. Duty area or task qualification should be documented using a similar method (for facilities that use duty area or task qualification instead of position qualification). Functional supervisors should have access to qualification records, as necessary, to support the assignment of work to qualified personnel.

Upon requalification, records that support the previous technical qualification may be removed from the record and replaced with the information documenting present qualification.

In addition, records of the training programs (including an audit trail documenting the development and modifications to each program) and evaluations of the effectiveness of those programs should also be maintained.

**c. List and discuss the items that would typically be found in an individual training and qualification record.**

See KSA b of this competency for a discussion of individual training and qualification records.

**d. List and discuss the items that would typically be found in a training program record.**

See KSA b of this competency for a discussion of training program records.

**e. Explain the legal aspects associated with accessing individual training and qualification records.**

The following is taken from DOE M 360.1-1B.

For each incident of training, the following records must be maintained and be accessible to employees and officials with oversight responsibilities: training participant name and identification number, approving and authorizing official(s), objective(s), source, location, cost, duty and non-duty training hours, beginning and end dates, and evaluation/completion

documentation. In addition, tax liability and continued service obligation records must be maintained, if applicable.

Training information management system requirements. Employee training records must be maintained in a manner consistent with the requirements of the Corporate Human Resource Information System.

Maintenance of training records. Each DOE element's training policies and procedures must designate an official(s) responsible for maintaining accurate and complete employee training records.

Disposition of employee training records. Employee training records must be available to the employee and upon reassignment, transfer, or separation, employees must be provided a complete copy, or equivalent documentation, of their record of training while employed by DOE.

**f. Describe the difference between an archival records system and a dynamic record retrieval system.**

An archival records system is a repository for the non-current records of an organization or institution which are kept because the records have value to that institution. The values can be historical and/or administrative, fiscal, or legal.

A dynamic record retrieval system is a record management system in which records are changed, added to, or edited as conditions change.

**g. Audit the training and qualification records for an assigned area or office, and report the results of the audit, including recommendations for improvement.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion.

**h. Discuss the training and qualification documentation expected to be found in the training and qualification records for instructors, including OJT instructors.**

The following is taken from DOE-HDBK-1001-96.

Auditable records of each individual's participation and performance in, or exception(s) granted from, the training program(s) (instructional and technical as appropriate) should be maintained. Individual training records should include the following (as appropriate):

- Verified education, experience, employment history, and most recent health evaluation summary
- Training programs completed and qualification(s) achieved
- Latest completed checklists, graded written examinations (with answers corrected as necessary or examination keys) and operational evaluations used for qualification (this requires controlled access to training records to maintain examination security)
- Lists of questions asked and the examiner's overall evaluation of responses on oral examinations
- Correspondence relating to exceptions granted to training requirements (including justification and approval)

- Records of qualification for one-time-only special tests or operations
- Attendance records for required training courses or sessions

A historical record that documents initial qualification on each position qualified should be maintained as part of individual training records. For example, if an instructor is initially qualified in 1986, the record should contain the date and name of the qualification. If more than one qualification is achieved and maintained, the individual training record should contain documentation to that effect.

Completed examinations, checklists, operational evaluations, etc., for presently held technical qualification(s) should be maintained in the record. (Some facilities may prefer to maintain a separate file of completed examinations with answer keys for each individual.) When an individual holds qualification in multiple positions, records that support current qualifications for each position should be maintained. Duty area or task qualification should be documented using a similar method (for facilities that use duty area or task qualification instead of position qualification). Functional supervisors should have access to qualification records, as necessary, to support the assignment of work to qualified personnel.

Upon re-qualification, records that support the previous technical qualification may be removed from the record and replaced with the information documenting present qualification. Superseded information should be handled in accordance with procedures contained in DOE Order 1324.5B, *Records Management Program*.

In addition, records of the training programs, including an audit trail documenting the development and modifications to each program and evaluations of the effectiveness of those programs should also be maintained.

**i. Audit the training and qualification records for a training organization and report the results of the audit, including recommendations for improvement.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion.

**j. Using DOE-HDBK-1118-99, Guide to Good Practice for Continuing Training, describe the elements of an adequate continuing training program for operators, supervisors, technical personnel, and maintenance personnel, and the records for each.**

The following is taken from DOE-HDBK-1118-99.

The long-term goal of a continuing training program should be to maintain and improve employee job performance. A short-term goal of continuing training should be to identify and correct weaknesses in their performance. To help in accomplishing these goals, the objectives and priorities of continuing training should be determined by using needs analyses, job analyses, feedback from facility managers, supervisors, and trainees, periodic evaluation of performance during facility operation, operating experience, compliance training, and the results of examinations. Whenever continuing training is conducted using material originally developed for initial training purposes, the specific objectives to be covered should be clearly defined.

To maintain and enhance the proficiency of facility personnel, a program with both a fixed and a flexible component is suggested. The fixed component is designed to maintain proficiency by providing a structured review of topics selected from the initial training program over a two-year period. The flexible component is used to correct actual or potential weaknesses of personnel and to train on operating experiences, modifications, and procedure changes.

Each facility should have a process for assessing the strengths and weaknesses of their personnel. This process should include analysis of job and training performance evaluations, examination results, interviews designed to assess knowledge, or any combination of these methods. This information should be used to help in determining topics for continuing training and the minimum acceptable standards of performance for individuals. Additional attention and priority should be given to areas of individual and team weaknesses.

#### *Fixed Continuing Training*

The fixed component of a continuing training program should satisfy needs and job analysis results, regulatory compliance training, general employee training, and fundamentals training.

Analysis data. Facility-specific analysis data should provide the basis for the continuing training program content to be covered, as well as an initial indication of the desired frequency at which they should be covered. Various forms of analyses may be used depending on the job position and the hazard level of the facility to determine continuing training program content. For example, a needs and job analysis may be required for operators and maintenance personnel whereas a broad-based needs assessment may be appropriate for technical staff and management personnel at the same high-hazard facility. DOE-HDBK-1074-95 provides additional guidance on which type of analysis would be used under different circumstances.

If a job analysis has been performed, the task difficulty, importance, and frequency (DIF) of performance should be weighed to determine both frequency and depth of presentation. This may be accomplished using the classic DIF decision tree referenced in the Guidelines for Job and Task Analysis for DOE Nuclear Facilities, or the alternative approach suggested in DOE-HDBK-1076-94. In either case, tasks will be selected as train, no train, pre-train, or overtrain.

The selection of train, no train, pre-train, and overtrain tasks should always be validated by SMEs and management. All tasks that may be performed by facility personnel should be considered. Those tasks identified as overtrain tasks during the job analysis process are by definition tasks that require both initial and continuing training to maintain proficiency. The content for continuing training programs should be identified during the design phase of the SAT process and based on the learning objectives derived from the task statements. The learning objectives derived from the overtrain task statements represent the knowledge and skills necessary to perform these tasks and should be the basis for a major part of the fixed portion of the continuing training program. Pre-train tasks are those tasks that are performed very infrequently and for which there is adequate time to provide training just prior to performance (“just in time training”). Training for pre-train tasks should also be included in the continuing training program to ensure that the training is actually conducted prior to

performing the task. For more information on the design process, refer to the following DOE handbooks: DOE-HDBK-1086-95; DOE-HDBK-1074-95; and DOE-HDBK-1078-94.

If the number of tasks selected as overtrain is found to be unmanageable, the tasks may need to be re-evaluated by training, SMEs, and operations and training management to ensure they were classified correctly. A table-top process as described in DOE-HDBK-1076-94 should be used to conduct this re-evaluation. It may not be possible to cover all the learning objectives for all the overtrain tasks in a two-year period. Therefore, some of the learning objectives for the overtrain tasks may have to be presented on a frequency less often than once every two years.

At low-hazard nuclear facilities it is possible that none of the tasks would be selected as overtrain tasks or the number of overtrain tasks may be very small. In this case, the fixed portion of the continuing training program may be based primarily on regulatory training. The number of pre-train tasks is normally small and these tasks are performed infrequently enough that they can easily be accommodated in the continuing training program schedule if they are identified early and are well planned.

When an analysis other than a job analysis is performed, the continuing training program should be based on the activities/competencies which, if performed incorrectly, would have an impact on safety and require continued practice or performance to maintain proficiency.

Regulatory compliance training. Regulatory compliance training should be part of the fixed component of the continuing training program. This is the mandated training required by DOE Orders and Federal regulations, such as security training and OSHA training, and can readily be scheduled well in advance. Training personnel should monitor DOE Orders, Federal regulations, and special reports for information and changes in requirements influencing training. These changes should be incorporated into the continuing training program and also documented and tracked.

General employee training (GET). Changes to the GET should be part of the continuing training program for all facility personnel. An exact repeat of the GET received during the initial training is not required. Instead, any changes that may have occurred to the topic areas addressed in the initial GET program should be included in the continuing training program.

Trainee proficiency should be measured periodically by administering examinations on the areas of the GET program that were included in the continuing training program.

Fundamentals training. Continuing training should include selected fundamentals or knowledge training. Basic knowledge, as well as specialized knowledge, can be lacking when infrequent operations occur or newly supplied equipment breaks down. Therefore, instructions on selected fundamental topics should be provided on a continuing basis. The topics chosen should maintain technical and/or operational knowledge and skills. The fundamentals portion of continuing training should be derived from analysis data, identified job deficiencies, examination results, and operating experiences.

#### *Flexible Continuing Training*

The content of the flexible component of a continuing training program should be based on feedback from line management, training evaluations, industry operating events, and changes to the facility and its procedures. The flexible portion of continuing training is a method for quickly updating personnel on changes to facility procedures, modifications to facility design, and recent industry or in-house operating experience. This information can be provided in different settings depending on the nature of the material. This portion of continuing training should keep personnel informed of changes to their jobs and keep them up-to-date on job-related industry events.

Items that could have an immediate impact on facility safety or reliability should be presented as soon as possible to the appropriate personnel. This may include presenting the information during the shift supervisor's pre-shift briefing. Management should emphasize the importance of the information and should communicate the management operational philosophy, standards, and concerns. All training provided should be documented, and attendance should be tracked to verify that all individuals receive the information provided by this means.

Individuals and teams should be assessed to determine their proficiency. Assessment methods include, but are not limited to, written examination, performance tests, laboratory exercises, simulator exercises, and oral evaluations. These assessments should be performed immediately after training, during the following weeks on the job if possible, or at the next continuing training cycle.

### **10. Technical training personnel shall demonstrate the ability to plan, conduct, and document an overall evaluation of a technical training and qualification program or activity, and report those results to management in a concise and effective manner.**

#### **a. Using DOE-STD-1070-94, Guidelines for Evaluation of Nuclear Facility Training Programs, describe the elements of an evaluation of a nuclear facility training program.**

The following is taken from DOE-STD-1070-94.

The objectives and criteria in appendix A to DOE-STD-1070-94 may be used individually by a person or collectively by a team to evaluate a specific objective or criterion or as a package to evaluate the entire training program. The objectives and criteria were designed to accommodate either the single person approach or the team approach. Job aids (i.e., checklists and forms) that can be used by either a person or by a team to support training program evaluation will be developed and published separately.

Training program evaluations should be conducted through observation of the overall program and should answer the question: “Does the training program meet the objectives and criteria contained in this standard?” The following resources should be used when conducting training program evaluations:

- Facility policies, procedures, program descriptions, and records
- Training materials such as lesson plans, guides, student handouts, and tests
- Cognizant facility personnel

Evaluations should be conducted at the facility, at the training center, and at other locations where training activities occur. Evaluations should center around three major activities to determine the extent to which training programs are meeting the objectives and criteria. These activities include observation of training, personnel interviews, and document reviews.

Observation of training should focus on the people (both instructors and trainees), the instructional environment, and the instructional process. The key steps involved in the observation of training are listed below:

- Select the training to be observed, obtain a copy of the lesson plan or guide, and review it prior to the observation.
- Explain the purpose of the observation to the instructor and attend training (but do not participate in the discussion or minimize trainee attention to the observation).
- Take detailed notes during the observation and write only facts.
- Compare the facts observed with the desired behaviors or conditions.
- Note any strengths and/or weaknesses.

Interviews require a different set of skills to acquire information about training. Successful interviewing is dependent on both speaking and listening skills, and on good questioning techniques. Key considerations during the interviewing process include the following:

- Pre-interview activities. Decide on goals for the interview, determine the key personnel who would provide the most complete and accurate information, and develop a set of questions in advance.
- Interview activities. Explain the interview purpose and answer any questions the interviewee may have, use open-ended questions to obtain detailed information, use closed questions to obtain short answer conclusions, assess throughout the interview, express appreciation for interviewee’s time, and restate the purpose of the interview at its conclusion.
- Post-interview activities. Compare responses to the objectives and criteria, and assess once again whether the information provided helped to accomplish the original goal(s) of the interview.

Training records should be reviewed to verify that materials and activities are being properly documented, processed, and retained. Program-level records include task lists, lesson plans, instructor qualifications, and program evaluations. Trainee-level records include attendance records, test results, qualification cards, and certifications. When inconsistencies exist, further investigation should be conducted to determine the depth of the problem. Assess the system as a whole. Are the records properly validated and entered into the system in a timely manner? Is there an effective document control system? Are all the records in the system and are they readily retrievable?

- b. Establish the criteria to be used as a basis for conducting the evaluation.
- c. Establish points of contact with the organization being evaluated.
- d. Gather information pertinent to the evaluation by reviewing training materials, interviewing personnel, observing training activities, and reviewing training records.
- e. Document the results of the data collection phase in field notes.
- f. Compare the results of the review phase with the criteria established for the evaluation and determine if deficiencies exist.
- g. Document the results of the overall training and qualification evaluation in a formal written report that includes the status of meeting the established criteria, identifies deficiencies or good practices, and suggests recommendations for improvement.
- h. Resolve conflicting or inconclusive observations or findings obtained from other evaluators on an evaluation team.
- i. Verbally report the results of the evaluation to contractor facility management and DOE management.
- j. Perform follow-up activities as applicable to ensure implementation of corrective actions, including tracking and close-out.
- k. Describe the process for determining and calculating a return on investment for a given training course or program.

Elements b through k are performance-based KSAs. The Qualifying Official will evaluate its completion.

**11. Technical training personnel shall demonstrate a working-level knowledge of the principles and functions of the Integrated Safety Management System (ISMS) and how integrated safety management (ISM) contributes to personnel competence.**

- a. Describe how the Guiding Principles in the ISM Policy are used to implement an ISM philosophy in Headquarters and field element technical training activities.

The following is taken from DOE M 450.4-1.

The guiding principle of competence commensurate with responsibilities includes the following elements that are related to technical training activities:

- The organization values and practices continuous learning, and requires employees to participate in recurrent and relevant training and encourages educational experiences to improve KSAs. Professional and technical growth is formally supported and tracked to build organizational capability.
- Training to broaden individual capabilities and to support organizational learning is available and encouraged:
  - to appreciate the potential for unexpected conditions.
  - to recognize and respond to a variety of problems and anomalies.



- to understand complex technologies and capabilities to respond to complex events.
- to develop flexibility at applying existing knowledge and skills in new situations.
- to improve communications.
- to learn from significant industry and DOE events.
- Training effectively upholds management’s standards and expectations. Beyond teaching knowledge and skills, trainers are adept at reinforcing requisite safety values and beliefs.

**b. Describe the core safety management functions in the ISM Policy and discuss how they provide the necessary structure for Headquarters and field element technical training activities.**

The following is taken from DOE P 450.4.

These five core safety management functions provide the necessary structure for any work activity that could potentially affect the public, the workers, and the environment. The functions are applied as a continuous cycle with the degree of rigor appropriate to address the type of work activity and the hazards involved.

- Define the Scope of Work. Missions are translated into work, expectations are set, tasks are identified and prioritized, and resources are allocated.
- Analyze the Hazards. Hazards associated with the work are identified, analyzed and categorized.
- Develop and Implement Hazard Controls. Applicable standards and requirements are identified and agreed-upon, controls to prevent/mitigate hazards are identified, the safety envelope is established, and controls are implemented.
- Perform Work within Controls. Readiness is confirmed and work is performed safely.
- Provide Feedback and Continuous Improvement. Feedback information on the adequacy of controls is gathered, opportunities for improving the definition and planning of work are identified and implemented, line and independent oversight is conducted, and, if necessary, regulatory enforcement actions occur.

**c. Discuss the role of the technical trainer in the fulfillment of the third ISM principle, Competence Commensurate with Responsibility, ensuring that personnel “possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities.”**

Refer to element a of this competency for a discussion of the role of the technical trainer regard the third ISM principle.

- d. **Identify specific and significant site or Headquarters work activities where the third ISM principle has been applied to improve safety.**
- e. **Describe and cite examples of how technical training personnel contribute to the ISM function, Provide Feedback and Continuous Improvement, such as with lessons learned programs.**
- f. **Review and revise an existing training program or course to incorporate applicable ISM principles, functions, and/or practices.**

Elements d through f are performance-based competencies. The Qualifying Official will evaluate their completion.

**12. Technical training personnel shall demonstrate a working-level knowledge of DOE O 360.1B, Federal Employee Training, DOE M 360.1-1B, Federal Employee Training Manual, and DOE M 426.1-1, Federal Technical Capability Manual, sufficient to ensure that training programs for federal personnel are accomplished in accordance with the requirements of the Order.**

**[DOE-M 426.1-1 has been replaced by DOE O 426.1.]**

- a. **Discuss the duties and responsibilities of line management, headquarters personnel, and training support personnel as indicated in the Order and manual.**

The following is taken from DOE O 360.1B.

*Line Management Duties and Responsibilities*

The duties and responsibilities of site managers include the following:

- Approve training policies and procedures for their DOE element
- Prioritize critical needs, provide resources for, plan, assess, and report on training consistent with DOE strategic planning, budget, succession planning, and training administration processes, with specific attention to
  - requirements of statutes, regulations, and DOE directives
  - DOE strategic plan and mission goals and objectives
  - governmental and DOE-wide policy and management functions
  - scientific and technical personnel and related materials, work processes, security, safety, health, environmental, nuclear, and technical operations needs
  - manager, supervisor, and team leader training appropriate to the duties and responsibilities of their positions and succession planning needs
- Define mandatory training requirements for employees in their element, including manager and supervisor training among other responsibilities
- Ensure efficient and effective management of training programs for their site's workforces
- Designate training approval and authorization officials for their DOE site
- Assign responsibilities for training requirements and functions, including designation of a training official(s) and a DOE point of contact and an alternate for training programs

- Approve their site's participation in training agreements governing multi-site programs
- Approve training agreements for their own site's programs, agreements with other DOE sites on one-to-one basis, and local geographic area interagency and intergovernmental training-related agreements
- Provide subject matter experts to meet training program requirements
- Waive training completion and continued service obligations for Federal employees prior to separation from DOE, as appropriate
- Approve acceptance of training-related awards, honorariums, and/or other contributions toward costs of training from Internal Revenue Service recognized 501(c)(3) organizations, with advice from the Office of General Counsel, as required

#### *Headquarters (HQ) Personnel Duties and Responsibilities*

The duties and responsibilities of HQ personnel include the following:

- The Secretary approves training requests for Presidential appointees, and concurs in training assignments involving the White House, Office of Management and Budget, and the Congress prior to the beginning date of the training.
- The Administrator for Nuclear Security or Designee is responsible for approving training agreements governing multi-site workforce development programs (three or more participating sites, research designed to improve DOE-wide training programs, and personnel management related authorities used under training agreements).

#### *Training Support Personnel Duties and Responsibilities*

The duties and responsibilities of training support personnel include the following:

- Manage assigned training functions, including, but not limited to
  - training compliance with applicable laws, regulations, policies, requirements, and provisions of training agreements
  - training policy and program development
  - training program cooperation and liaison with other DOE elements
  - training program evaluation and self-assessment
- Approve and coordinate additional approvals, authorizations, and/or concurrences for training for any Federal employee if officials with responsibility for that employee's training are not located at that duty station

### **b. Explain the latitude and restrictions associated with employee training.**

The following is taken from DOE O 360.1B.

Resources can only be invested in training when

- the training provides a structured approach to acquiring information, knowledge, skills, and/or developmental experience;
- the training is required by law, DOE directive, or head of element mandate, is related to performance improvement, or contributes to maintaining a highly skilled, diverse, and versatile workforce;
- the purpose and subject matter of the training are related to DOE's mission or benefit the Federal government any time that the goals of the training include placement in another Federal agency;

- it is expected that the training participant will use the competencies learned to perform current or anticipated duties after completion of the training for a period at least equal to the duration of the training or an applicable continued service obligation.

No training funds can be expended for licenses, certificates, and other types of recognized occupational qualification tests or examinations. This restriction does not affect the use of examinations that are integral to training, that test participant learning related to the training, that must be accomplished successfully to meet training completion requirements, and that incidentally qualify an individual or group, in whole or in part, for a license or certificate.

Training that purposely leads to an academic degree must be provided only under a training agreement consistent with the provisions of 5 CFR 410.308, "Training to Obtain an Academic Degree." This restriction does not limit otherwise authorized training that incidentally provides credit toward a degree, certification, or other academic or professional recognition.

If a supervisory, approving, or authorizing official becomes aware that a training assignment, program, or location is inconsistent with (1) DOE policy or program interests or responsibilities; (2) required provision of accommodations for handicapped individuals; (3) equal employment opportunity requirements; or (4) religious or strongly held personal values of a participant(s), the official must take action to resolve such inconsistencies and/or terminate the training or, in the case of conflict with strongly held religious or personal values, allow an individual(s) to withdraw from the training, with appropriate waiver of training completion requirements.

### **c. Describe the requirements for training plans, resources, and reports.**

The following is taken from DOE M 360.1-1B.

Each DOE element must have a training plan which describes the following:

- Element critical needs or those immediate training needs that, when met, will be effective in improving organizational and workforce performance
- Training goals and objectives
- Training outcome and performance measures
- Federal training staff and estimated training staff travel funds
- Training budget, including future resource estimates for multi-year programs
- Major training delivery programs, projects, and other significant activities
- Schedules for review and revision of individual development plans, conduct of needs assessment(s), completion of annual training summary report, and initiation of periodic review of training plan
- Mandatory training
- Manager, supervisor, and team leader training
- Each DOE element that provides DOE-wide or multi-element training must have a separate component of its training plan for that multi-element training program(s)

Training resources include the following:

- Elements must include training funding in budget submissions, prioritize training needs, and allocate resources accordingly in training plans.
- Each DOE element, in allocating resources to support training programs, must give due consideration to DOE and element strategic objectives; training required by law, regulation, DOE directive, or a technical qualification or work performance competency standard; and individual training needs as determined through element needs analyses and functional, occupational, and individual needs assessments and individual development plans.
- Training costs can be paid from program funds where the training supports DOE mission and program objectives and the training is an administratively practical method of meeting the necessary program expense of ensuring performance of assigned DOE duties.
- Travel funds may be used to pay conference fees where the conference qualifies as a training activity and official travel is approved to attend the conference.
- Funds, up to the cost of training programs or services provided to non-DOE participants (or equivalent training services), must be received and credited to the DOE or other appropriation supporting such training activities in accordance with law and standard Federal government and DOE accounting policies and procedures.
- DOE contractors, citizens, and other persons on an individual basis can only participate in training paid for with DOE Federal employee training funds (a) on a space-available basis, (b) if it will benefit DOE, and (c) either direct statutory or contract authority exists to provide such training or participation would be at no-material-cost to DOE.
- Training costs, contributions, awards, or services paid for by Internal Revenue Service designated 501(c)(3), nonprofit organizations may be accepted by employees after receiving approval in accordance with element policies and/or procedures.

Each DOE element must complete an annual training summary report on objectives, costs, and incidents of training that describes at least the following:

- accomplishments in relation to critical needs, goals, objectives, and training outcome and performance measures
- training expenditures compared to number of Federal training staff, training staff travel funds, and program funds budgeted
- annual information as requested

DOE elements that provide training under training agreements must have a specific, separate component of their annual summary report that describes the training.

The Office of Training and Human Resource Development must prepare an annual training summary report describing costs, instances, and accomplishments relative to critical, training related, DOE mission objectives and DOE-wide training goals and needs.

**d. Explain the requirements associated with requesting and using training resources as described in the Order.**

The following is taken from DOE M 360.1-1B.

The training participant ensures completion of, a supervisory official approves, and a designated official authorizes training requests in accordance with element training policy and procedures and/or applicable workforce development program training agreements.

- Training as a work assignment. Training that DOE pays for in whole or in part is an employee work assignment subject to DOE and DOE element workplace policies and procedures, including time and attendance and leave approval.
- Preparation of training requests. The participant ensures completion of the training request, with appropriate assistance of designated staff, in accordance with the DOE element's training policies and procedures. If a continued service agreement is required, it must be signed and submitted with the training request.
- Training approval. Training approval, i.e., certification that training is an appropriate expense related to improving DOE mission-related performance, is a supervisory function; it may be delegated to a non-supervisory official, such as a team leader or senior professional employee, but no employee can approve his or her own training request and no subordinate individual can approve training for a superior.
- Training authorization. Second-level supervisory officials (managers) or a designated training official(s) must be assigned responsibility for training authorization, i.e., the certification that the training meets legal and administrative requirements and that appropriate funds are available.
- Status of training requests. Employees must be notified of action on training requests in a timely manner.
- Notification of participation. Employees must be notified of approved participation or registration a minimum of 7 days in advance of the start date for training provided by DOE or a DOE element, unless special circumstances exist.
- Concurrence of the Secretary. The Secretary must concur in training involving the White House, the Office of Management and Budget, or the Congress. A memorandum requesting the concurrence must be sent to the Secretary with a copy of the approved and authorized training request as an attachment.

**e. State the purpose and requirements associated with establishing workforce development programs with employees.**

The following is taken from DOE-M 360.1-1B.

The purpose associated with establishing workforce development programs is to meet organizational and/or work performance objectives based on management's determination that the nature or quantity of work or the composition of the workforce requires improvement in workforce competency levels and/or reassignment of individuals to meet current or new requirements. This includes training programs under DOE training centers of excellence, academic degree training, work experience or developmental training assignments at non-Federal sites or organizations, and career transition training, including those programs designed to place DOE employees in positions potentially available in other Federal agencies.

The head of a DOE element must approve training agreements governing element workforce development programs, i.e., programs where 80 percent or more of the resources, participants and/or positions affected are projected to come from a single DOE element or, by mutual agreement, involve primarily two DOE elements.

Multi-element programs. The Director, Management, Budget and Evaluation (and/or NNSA designee, if applicable), must approve training agreements involving employees and/or positions in three or more DOE elements, including training centers of excellence, where less than 80 percent of the resources or fewer than 80 percent of the affected employees and/or positions are in one DOE element.

Programs funded and approved as part of the DOE strategic plan and/or budget process may be considered as having the equivalent of a training agreement; however, the Director, Management, Budget and Evaluation (and/or NNSA designee, if applicable) must approve an implementation plan for such DOE multi-element programs.

**f. Describe the requirements of the Federal Technical Capability Program (FTCP), including the Technical Qualification Program.**

The following is taken from DOE P 426.1.

The FTCP provides for the recruitment, deployment, development, and retention of Federal personnel with the demonstrated technical capability to safely accomplish the Department's missions and responsibilities. The FTCP is institutionalized through DOE directives to establish the program's objective, guiding principles, and functions. The program is specifically applicable to those offices and organizations performing functions related to the safe operation of defense nuclear facilities. It is applied to all aspects of recruitment, deployment, development, and retention of Federal employees in these organizations.

**g. Conduct a gap analysis of the requirements of the above directives regarding how or whether they are being implemented in the assigned organization.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion.

**13. Technical training personnel shall demonstrate a working level knowledge of the content and applicability of the DOE resources and guidance documents related to the implementation of DOE federal and contractor training programs.**

**a. Describe the general content and explain the use and applicability of the DOE guides to good practice for training and qualification programs and processes.**

DOE-HDBK-1078-94 describes a systematic method for establishing and maintaining training programs. The SAT includes five distinct, yet interrelated, phases. These phases include analysis, design, development, implementation, and evaluation. SAT is consistent with other systematically based training systems such as performance-based training, training system development, instructional systems development, and other similar methods. The systematic approach method may also be used in conjunction with other DOE Orders and directives that contain personnel training and qualification requirements.

DOE-HDBK-1078-94 describes the more classical concept and approach to systematically establishing training programs. However, in some cases this approach has proven to be time- and labor-intensive, especially if excessive detail is expected. The risk and complexity associated with performance of a job or the nuclear hazard category of the facility affected

may warrant the use of simpler, less detailed alternative methods to achieve results that are both satisfactory and effective. These methods are discussed in other departmental and industry standards.

DOE-HDBK-1118-99, provides guidance to DOE staff and contractors that can be used to modify existing continuing training programs or to develop new programs. Continuing training is necessary to ensure that operating organization personnel continually improve their ability to operate, maintain, and provide support to their nuclear facility(ies) in a safe and reliable manner. Continuing training should also enhance the professionalism of these individuals and should make them aware of the possible consequences of misoperation. DOE contractors should not feel obligated to adopt all parts of this guide.

DOE-HDBK-1001-99, contains good practices for the training and qualification of technical instructors and instructional technologists at DOE reactor and non-reactor nuclear facilities. It addresses the content of initial and continuing instructor training programs, evaluation of instructor training programs, and maintenance of instructor training records.

DOE-HDBK-1001-99 was developed from three principal sources:

- Commercial nuclear power industry guidelines for instructor training and qualification
- The Mid-Atlantic Nuclear Training Group Generic Instructor Task List
- A tabletop analysis conducted to identify instructional competencies representative of those required by DOE's Training Accreditation Program objectives and criteria

Training programs at DOE facilities should prepare personnel to safely and efficiently operate and maintain the facilities in accordance with DOE requirements. DOE-HDBK-1206-98, presents good practices for performance-based OJT and OJT programs.

- b. Research such professional sources as the American Society for Training and Development (ASTD), American Nuclear Society (ANS), and American National Standards Institute (ANSI), as may be found on the Internet, for applicable technical training and qualification information and materials; incorporating the research results into an assigned training project or program.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion.

**14. Technical training personnel shall demonstrate a working-level knowledge of the requirements of applicable DOE Orders and rules to determine if a contractor at a facility is implementing effective training and qualification programs.**

- a. Referring to the following sample of Orders and rules, describe the purpose, applicability, and roles and responsibilities as they pertain to oversight of contractor training and qualification programs.**
- 10 CFR 820, Procedural Rules for DOE Nuclear Activities
  - 10 CFR 830, Nuclear Safety Management
  - 10 CFR 835, Occupational Radiation Protection
  - DOE Order 5480.19, Conduct of Operations Requirements for DOE Facilities
  - DOE Order 5480.20A, Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities



- **DOE O 151.1C, Comprehensive Emergency Management System**
- **DOE O 350.1, Contractor Human Resource Management Programs**
- **DOE O 414.1C, Chg 1, Quality Assurance**
- **DOE O 425.1C, Start-up and Restart of Nuclear Facilities**
- **DOE O 430.1B, Real Property Asset Management**

#### *10 CFR 820, Procedural Rules for DOE Nuclear Activities*

10 CFR 820.2 defines “DOE Nuclear Safety Requirements” as “the set of enforceable rules, regulations, or orders relating to nuclear safety adopted by DOE (or by another Agency if DOE specifically identifies the rule, regulation, or order) to govern the conduct of persons in connection with any DOE nuclear activity and includes any programs, plans, or other provisions intended to implement these rules, regulations, orders, a nuclear statute or the Atomic Energy Act, including technical specifications and operational safety requirements for DOE nuclear facilities. For purposes of the assessment of civil penalties, the definition of DOE Nuclear Safety Requirements is limited to those identified in 10 CFR 820.20, “Purpose and Scope,” states that civil penalties may be assessed on the basis of a violation of any DOE nuclear safety requirement, a compliance order, or any program, plan, or other provision required to implement such requirement or compliance order.

#### *10 CFR 830, Nuclear Safety Management*

10 CFR 830.121, “Quality Assurance Program,” establishes quality assurance requirements for contractors conducting activities, including providing items or services that affect, or that may affect, the nuclear safety of DOE nuclear facilities. This includes requirements for a contractor’s QAP.

10 CFR 830.202, “Safety Basis,” establishes safety basis requirements for hazard category 1, 2, and 3 DOE nuclear facilities. This includes requirements related to unreviewed safety questions, technical safety requirements, and documented safety analyses.

#### *10 CFR 835, Occupational Radiation Protection*

The rules in this part establish radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from the conduct of DOE activities. Some of the topics covered in this regulation are listed below:

- Radiation protection programs
- Internal audits
- Occupational dose limits for general employees
- Individual monitoring
- Air monitoring
- Radiological areas
- Labeling items and containers
- Radiation safety training
- Facility design and modifications
- Workplace controls
- Nuclear accident dosimetry

#### *DOE Order 5480.19, Conduct of Operations Requirements for DOE Facilities*

**[DOE Order 5480.19 will be replaced by DOE O 422.X.]**

The objective of DOE O 422.X is to define the requirements for establishing and implementing conduct of operations programs at DOE/NNSA facilities and projects. A conduct of operations program consists of formal documentation, practices, and actions implementing disciplined and structured operations that support mission success and promote worker, public, and environmental protection. The goal is to minimize the likelihood and consequences of human fallibility, human capability misalignments, or technical and organizational system failures. Conduct of operations is one of the safety management programs recognized in the Nuclear Safety Rule, but it also supports safety and mission success for a wide range of hazardous, complex, or mission-critical operations, and some conduct of operations attributes can enhance even routine operations. It may be implemented through facility policies, directives, plans, and safety management systems and need not be a stand-alone program.

The term “operations” encompasses the work activities of any facility or project, from building infrastructure, to print shops and computer centers, to scientific research, to nuclear facilities. While many hazards can be dealt with through engineered solutions, people still have to perform operations, and they can and do make mistakes. The purpose of DOE O 422.X is to ensure that management systems are designed to anticipate and mitigate the consequences of human fallibility or unrecognized latent conditions and to provide a vital barrier to prevent injury or equipment damage and promote mission success.

*DOE Order 5480.20A, Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*

**[DOE Order 5480.20A will be replaced by DOE O 426.Y.]**

The purpose of DOE O 426.Y is to establish selection, training, qualification, and certification requirements for contractor personnel who can impact the safety basis through their involvement in the operation, maintenance, and technical support of hazard category 1, 2, and 3 nuclear facilities. The SAT as defined in the contractor requirements document of DOE O 426.Y is designed to ensure that these personnel have the requisite KSAs to properly perform work in accordance with the safety basis. 10 CFR 830, requires quality assurance plans and documented safety analyses to address training. The training programs established to comply with DOE O 426.Y support those requirements. DOE O 426.Y updates and consolidates DOE training requirements consistent with applicable aspects of current industry standards. Implementation of the requirements of DOE O 426.Y will meet 10 CFR 830.122, “Quality Assurance Criteria.”

*DOE O 151.1C, Comprehensive Emergency Management System*

The purpose of DOE O 151.1C is

- To establish policy and to assign and describe roles and responsibilities for the DOE Emergency Management System. The Emergency Management System provides the framework for development, coordination, control, and direction of all emergency planning, preparedness, readiness assurance, response, and recovery actions. The Emergency Management System applies to DOE and to the NNSA.
- To establish requirements for comprehensive planning, preparedness, response, and recovery activities of emergency management programs or for organizations requiring DOE/NNSA assistance.

- To describe an approach to effectively integrate planning, preparedness, response, and recovery activities for a comprehensive, all-emergency management concept.
- To integrate public information and emergency planning to provide accurate, candid, and timely information to site workers and the public during all emergencies.
- To promote more efficient use of resources through greater flexibility (i.e., the graded approach) in addressing emergency management needs consistent with the changing missions of the Department and its facilities.
- To ensure that the DOE Emergency Management System is ready to respond promptly, efficiently, and effectively to any emergency involving DOE/NNSA facilities, activities, or operations, or requiring DOE/NNSA assistance.
- To integrate applicable policies and requirements, including those promulgated by other Federal agencies (e.g., stockpiling stable iodine for possible distribution as a radiological protective prophylaxis), and interagency emergency plans into the Department's Emergency Management System. In compliance with the statutory requirements, DOE finds that DOE O 151.1C is necessary for the fulfillment of current legal requirements and conduct of critical administrative functions.
- To eliminate duplication of emergency management efforts within the Department.

*DOE O 350.1, Contractor Human Resource Management Programs*

The objectives of DOE O 350.1 are

- to establish DOE responsibilities, requirements, and cost allowability criteria for the management and oversight of contractor human resource management (HR) programs.
- to ensure that DOE contractors manage their HR programs to support the DOE mission, promote workforce excellence, champion workforce diversity, achieve effective cost management performance, and comply with applicable laws and regulations.
- to implement consistent requirements that allow contractors flexibility in determining how to meet the requirements.
- to ensure that all elements of cash and non-cash compensation are considered in the design and implementation of an appropriate total compensation philosophy but are not used as a means to deflect needed cost reductions in either or both.

Requirements are set forth in chapters I through IX of DOE O 350.1.

*DOE O 414.1C, chg 1, Quality Assurance*

The objectives of this Order are

- to ensure that DOE/NNSA, products and services meet or exceed customers' expectations.
- to achieve quality assurance (QA) for all work based upon the principles
  - that quality is assured and maintained through a single, integrated, effective QAP (i.e., management system);
  - that management support for planning, organization, resources, direction, and control is essential to QA;
  - that performance and quality improvement require thorough, rigorous assessment and corrective action;
  - that workers are responsible for achieving and maintaining quality;

- that environmental, safety, and health risks and impacts associated with work processes can be minimized while maximizing reliability and performance of work products.
- to establish quality process requirements to be implemented under a QAP for the control of suspect/counterfeit items, safety issue corrective actions, and safety software.

Requirements for QAPs and the quality criteria are set forth in section 4a and 4b of DOE O 414.1C.

*DOE O 425.1C, Start-Up and Restart of Nuclear Facilities*

The purpose of DOE O 425.1C is to establish the requirements for the DOE/NNSA for startup of new nuclear facilities and for the restart of existing nuclear facilities that have been shut down. Nuclear facilities are activities or operations that involve radioactive and/or fissionable materials in such form or quantity that a nuclear hazard potentially exists to the employees or the general public. The requirements specify a readiness review process that must, in all cases, demonstrate that it is safe to start (or restart) the applicable facility. The facility must be started (or restarted) only after documented independent reviews of readiness have been conducted and the approvals specified in this Order have been received. The readiness reviews are not intended to be tools of line management to achieve readiness. Rather, the readiness reviews provide an independent confirmation of readiness to start or restart operations.

Requirements associated with operational readiness reviews are available in section 4 of DOE O 425.1C.

*DOE O 430.1B, Real Property Asset Management*

The purpose of DOE O 430.1B is to establish a corporate, holistic, and performance-based approach to real property life-cycle asset management that links real property asset planning, programming, budgeting, and evaluation to program mission projections and performance outcomes. To accomplish the objective, DOE O 430.1B identifies requirements and establishes reporting mechanisms and responsibilities for real property asset management.

**b. Identify, retrieve, and prepare a summary of all the applicable Orders and rules for training and qualification oversight activities for a given DOE facility.**

This is a performance-based KSA. The local Qualifying Official will evaluate its completion.

**c. State and describe the purpose and applicability of DOE-STD-1070-94, Guidelines for Evaluation of Nuclear Facility Training Programs.**

DOE-STD-1070-94 establishes a single set of objectives and criteria for the evaluation of training programs developed to meet the requirements of DOE Order 5480.20A and other directives that address training and qualification. For the purpose of this standard, evaluation includes appraisals, surveillances, audits, reviews, assessments, and other activities intended to evaluate training. The standard is intended to assist personnel in performing evaluations of training and qualification programs. It should be used in conjunction with other regulations, policies, or directives that require the evaluation of training and qualification programs.

### *Purpose*

DOE-STD-1070-94 establishes objectives and criteria for evaluating nuclear facility training programs. The guidance in DOE-STD-1070-94 provides a framework for the systematic evaluation of training programs at nuclear facilities and is based, in part, on established criteria for technical safety appraisals, commercial nuclear industry evaluations, and the DOE training accreditation program.

### *Applicability*

DOE-STD-1070-94 applies to organizations or persons involved in evaluating training methods, materials, and programs at DOE nuclear facilities. DOE nuclear facilities include category A reactor facilities, category B reactor facilities, and non-reactor nuclear facilities. The focus of the standard is evaluations that are conducted by DOE field organizations. It should also be used by others who conduct reviews of training, whether internal or external to the Department.

Training programs will vary according to the complexity and hazard potential of a particular nuclear facility. Consequently, certain criteria may not be applicable to low-hazard facilities; hence, a degree of flexibility must be used when applying the criteria. When a criterion is not applicable, it need not be considered.

While DOE-STD-1070-94 assumes specific methods of evaluation, alternate methods that are consistent with overall organizational needs, policies, and resources are acceptable.

- d. Apply the evaluation process indicated in DOE-STD-1070-94, including evaluation methods, evaluation frequency, and the application of a graded approach to an assigned evaluation of a contractor's training program, and report the results.**

This is a performance-based KSA. The local Qualifying Official will evaluate its completion.

- e. Describe the process for determining adequate compliance with the requirements listed in the above orders and rules and the severity and consequences associated with not being in compliance.**

The objectives and criteria in appendix A of DOE-STD-1070-94 may be used individually by a person or collectively by a team to evaluate a specific objective or criterion or as a package to evaluate the entire training program. The objectives and criteria were designed to accommodate either the single person approach or the team approach. Job aids (i.e., checklists and forms) that can be used by either a person or by a team to support training program evaluation will be developed and published separately.

Training program evaluations should be conducted through observation of the overall program and they should answer the question: "Does the training program meet the objectives and criteria contained in this standard?" The following resources should be used when conducting training program evaluations:

- Facility policies, procedures, program descriptions, and records
- Training materials, such as lesson plans, guides, student handouts, and tests
- Cognizant facility personnel

Evaluations should be conducted at the facility, at the training center, and at other locations where training activities occur. Evaluations should center around three major activities to determine the extent to which training programs are meeting the objectives and criteria. These activities include observation of training, personnel interviews, and document reviews. Observation of training should focus on the people (both instructors and trainees), the instructional environment, and the instructional process. Following are the key steps involved in the observation of training:

- Select the training to be observed, obtain a copy of the lesson plan or guide, and review it prior to the observation.
- Explain the purpose of the observation to the instructor and attend training (but do not participate in the discussion or minimize trainee attention to the observation).
- Take detailed notes during the observation and write only facts.
- Compare the facts observed with the desired behaviors or conditions.
- Note any strengths and/or weaknesses.

Interviews require a different set of skills to acquire information about training. Successful interviewing is dependent on both speaking and listening skills, and on good questioning techniques. Key considerations during the interviewing process include the following:

- Pre-interview activities. Decide on goals for the interview, determine the key personnel who would provide the most complete and accurate information, and develop a set of questions in advance.
- Interview activities. Explain the interview purpose and answer any questions the interviewee may have, use open-ended questions to obtain detailed information, use closed questions to obtain short answer conclusions, assess throughout the interview, express appreciation for interviewee's time, and restate the purpose of the interview at its conclusion.
- Post-interview activities. Compare responses to the objectives and criteria and assess once again whether the information provided helped to accomplish the original goal(s) of the interview.

Training records should be reviewed to verify that materials and activities are being properly documented, processed, and retained. Program-level records include task lists, lesson plans, instructor qualifications, and program evaluations. Trainee-level records include attendance records, test results, qualification cards, and certifications. When inconsistencies exist, further investigation should be conducted to determine the depth of the problem. Assess the system as a whole. Are the records properly validated and entered into the system in a timely manner? Is there an effective document control system? Are all the records in the system and are they readily retrievable?

**15. Technical training personnel shall demonstrate a working-level knowledge of basic assessment principles and processes associated with evaluating DOE contractors such as operational readiness reviews (ORRs), readiness assessments (RAs), and business management oversight reviews. This includes the planning and use of observations, interviews, and document reviews to assess compliance with established criteria or requirements.**

**a. Describe the role of the evaluator with respect to performance of oversight of contractors at government-owned, contractor-operated facilities.**

The following is taken from DOE O 226.1A.

As contracting officers, DOE line management must periodically evaluate contractor performance in meeting contractual requirements and expectations.

- A combination of DOE line management oversight, contractor self-assessments, and other performance indicators must be used to evaluate contractor performance.
- DOE line management must evaluate the effectiveness of management programs, including environment, safety, and health; safeguards and security; cyber security; and emergency management. Poor performance in these areas must have significant negative consequences on evaluations and fee determination. In accordance with contract provisions, evaluations must be used to reward significant accomplishments and/or performance improvements.
- Quantitative performance indicators and measures may be used to support the evaluation of a contractor; however, such indicators provide only a partial indication of system effectiveness and must be considered in combination with assessment results.
- Evaluations must be based on an analysis of the results of relevant information obtained or developed during the performance period, including contractual performance measures and objectives, DOE line management oversight, contractor self-assessments, operational history/events, and reviews by DOE and external organizations.

**b. Describe the requirements and limitations associated with the evaluator's interface with contractor employees when conducting assessments or evaluations.**

As assessment requirements and limitations associated with the interface of contractor employees vary from site to site, the local Qualifying Official will evaluate the completion of this KSA.

**c. Explain the impact of the Price-Anderson Amendments Act upon contractor oversight activities, particularly in the conduct of performance evaluations and enforcement actions associated with 10 CFR Parts 820, 830, and 835.**

The following is taken from 10 CFR 820.

Section IX of appendix A to 10 CFR 820 describes the enforcement sanctions available to DOE and specifies the conditions under which each may be used. The basic sanctions are notices of violation and civil penalties. In determining whether to impose enforcement

sanctions, DOE will consider enforcement actions taken by other Federal or state regulatory bodies having concurrent jurisdiction, e.g., instances which involve NRC licensed entities that are also DOE contractors, and in which the NRC exercises its own enforcement authority.

The nature and extent of the enforcement action is intended to reflect the seriousness of the violation involved. For the vast majority of violations for which DOE assigns severity levels a notice of violation will be issued, requiring a formal response from the recipient describing the nature of and schedule for corrective actions it intends to take regarding the violation. Administrative actions, such as determination of award fees where DOE contracts provide for such determinations, will be considered separately from any civil penalties that may be imposed under this enforcement policy. Likewise, imposition of a civil penalty will be based on the circumstances of each case, unaffected by any award fee determination.

**d. Explain the essential elements of a performance-based assessment, including the areas of investigation, fact-finding, and reporting.**

The following is taken from DOE G 414.1-1A.

Investigations should be sufficiently thorough and information gathered with sufficient diligence that accurate, detailed conclusions and issues can be provided to assist the organizations that will receive the final report.

In using any of the following techniques, assessors should maintain good records of the assessment results. These may include personal notes or other information to support the assessment and may be included in the checklist information. These records are useful in writing the report and any associated findings and recommendations and will become invaluable if questions arise during the report review process. All classified notes should be disposed of properly in accordance with established and agreed-upon procedures. A discussion of each of the techniques follows.

*Document Review*

Document review is used extensively during an assessment to substantiate the information obtained during interviews and observation. During the course of an assessment, questions may arise concerning what is heard and seen. The review of documents provides a method for answering these questions and validating the assessment results. The drawback of document review is that the accuracy of the records cannot be ascertained by review alone. This technique should be combined with interviews, observation, inspection, and/or performance testing to complete the picture of performance. Records and documents should be selected carefully to ensure they adequately characterize the program, system, or process being assessed.

*Interviews*

Interviews provide a means to verify the results of observation, document review, inspection, and performance testing. In addition, interviews allow the responsible person to explain and clarify those results. The interview helps to eliminate misunderstandings about program implementation and provides a venue where apparent conflicts or recent changes can be discussed and the organization and program expectations can be described. Tools developed



during assessment planning are used to prepare for the interview. Assessors should also prepare questions in advance to keep the interview focused.

### *Observation*

Observation, the viewing of actual work activities, is often considered the most effective technique for determining whether performance is adequate. Assessors should understand the effect their presence has on the person being observed and convey an attitude that is helpful, constructive, positive, and unbiased. The primary goal during observation is to obtain the most complete picture possible of the performance, which should then be put into perspective relative to the overall program, system, or process. Before drawing final conclusions, the assessor should verify the results through at least one other technique.

### *Inspection*

Inspections are performed to verify the adequacy and condition of physical facilities, systems, equipment, and components. Usually inspections are used to obtain additional information concerning other items evaluated during the assessment, such as equipment labeling, configuration control, the status of system lineups, adequacy of construction, or material storage. Inspections may also be performed to gain information and data for interviews and/or work observation. While on these inspections, the assessor must heed all security and safety requirements. It is always a good practice to be accompanied by someone familiar with the facility.

### *Performance Testing*

Performance testing is used to observe the response of personnel or equipment by creating a specific situation and noting performance. This technique is especially useful when activities of interest would not normally occur during an assessment visit. It is also used when timeliness and appropriateness of the response are critical to an organization.

### *Assessment Reports*

Assessment reports are required to communicate the issues identified during an assessment. Assessment team leaders have the overall responsibility for preparing the report and obtaining approval for its release from their senior management. The assessment report may be formal or informal, depending on the level of assessment performed, but should provide a clear picture of the results in terms of the programs, systems, and processes assessed. The report should be clear and easy to understand and should include only facts that directly relate to assessment observations and results. It should include sufficient information to enable the assessed organization to check the report for accuracy and to develop and implement appropriate improvement plans. Every effort should be made to ensure assessment reports are concise, accurate, and understandable. In preparing the report, authors should also remember that many people who will read the report have had no active role in the assessment and the report may be their only source of information regarding its conduct and results. A recognized good practice is to provide a draft copy of the report to the assessed organization to allow the staff to comment on the factual accuracy; however, the review is only to confirm factual accuracy, not to contest or argue the assessment team's conclusions.

Specific report formats may vary considerably from one organization to the next. In developing a report format, the assessment organization should solicit input from report recipients to ensure the report meets their needs.

**e. Explain the purpose and contents of a typical assessment report, and describe how to determine who should be on the distribution list for the report.**

The following is taken from DOE G 414.1-1A.

A typical assessment report usually includes the sections described below.

*Executive Summary*

This summary should be a brief, stand-alone document. It should describe the programs, systems, and processes assessed and the overall assessment results, including an evaluation of the effectiveness, efficiency, and adequacy of the area(s) assessed and the overall results. The executive summary should describe the strengths and weaknesses affecting the assessed organization, including barriers to performance, so that meaningful action can be taken for improvement.

*Observation Section*

Each part of this section should focus on the established assessment scope and the identified organization mission; otherwise, the recipient of the report will question why a specific area or activity was assessed. The section should include general background on the assessment, including team members, scope of the assessment, methodology used, and a summary of the assessment basis and source documents. This section should also include a detailed discussion of each area assessed, including specific performance criteria used and summaries of interviews, documents reviewed, observations, and inspections. The summaries contained in this section should support the specific items discussed under the results section.

Noteworthy practices identified during the assessment should also be documented so that the assessed organization and other organizations can learn and build upon them.

*Results Section*

This section should list and discuss specific problem areas or deficiencies, areas needing improvement, or noteworthy practices identified during the assessment. In addition, this section should highlight any recurring problems as indicators of ineffective corrective action by the assessed organization. For each item listed, the report should include a discussion of the specific performance criteria used and the basis for the nonconformance in sufficient detail to enable further analysis and action by the responsible organization. The report should also include any required post assessment actions by the assessed organization. For example, a series of “like” discrepancies may be symptoms of an underlying system problem.

Therefore, a single issue should be developed that cites the individual discrepancies as evidence of a system breakdown. Issues should be defined, labeled, and enumerated in a manner that facilitates a response. While this should be in accordance with the assessing organization’s assessment program, the language used should clearly distinguish objective noncompliances from observations, opinions, and improvement opportunities.

### *Attachments*

Attachments provide supplementary information to validate the assessment and its methodology. They can be helpful in planning corrective actions and follow-up. Items frequently included as attachments to assessment reports are the assessment agenda, a list of persons contacted, a list of documents reviewed, performance criteria, and the tools used to perform the assessment.

**f. Describe the actions to be taken if the contractor challenges the assessment findings and explain how such challenges can be avoided.**

The following is taken from DOE G 414.1-5.

Disputes over the assessment findings, the corrective action plan, or its implementation (such as timeliness or adequacy) must be resolved at the lowest possible organizational level. The organization that disagrees with the disposition of a given issue may elevate the dispute for timely resolution. The organization that disagrees with the disposition of a given issue must elevate the dispute in a step-wise manner through the management hierarchy. The dispute must be raised via a deliberate and timely dispute resolution process that provides each party with equal opportunity for input and a subsequent opportunity to appeal decisions up to the Secretary of Energy, if necessary.

**g. Participate on assigned contractor training and qualification assessments, including on-site evaluations, such as ORRs and RAs, and document reviews, preparing a report of the results of the assessment.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion.

**16. Technical training personnel shall demonstrate a working-level knowledge of contracts and procurement processes and procedures, and how they apply to procurement of training-related services or products.**

- a. Describe the process and requirements for paying for individual training courses as detailed in DOE O 360.1B, Federal Employee Training, and DOE M 360.1-1B, Federal Employee Training Manual.**

The following is taken from DOE M 360.1-1B.

Elements must include training funding in budget submissions, prioritize training needs, and allocate resources accordingly in training plans.

Each DOE element, in allocating resources to support training programs, must give due consideration to DOE and element strategic objectives; training required by law, regulation, DOE directive, or a technical qualification or work performance competency standard; and individual training needs as determined through element needs analyses and functional, occupational, and individual needs assessments and individual development plans.

Training costs can be paid from program funds where the training supports DOE mission and program objectives and the training is an administratively practical method of meeting the necessary program expense of ensuring performance of assigned DOE duties.

Travel funds may be used to pay conference fees where the conference qualifies as a training activity and official travel is approved to attend the conference.

Funds, up to the cost of training programs or services provided to non-DOE participants (or equivalent training services), must be received and credited to the DOE or other appropriation supporting such training activities in accordance with law and standard Federal government and DOE accounting policies and procedures. Examples of this are

- unique training provided to private sector corporations or individuals under the Work-for-Others program;
- professional, administrative, and technical training that is available to Federal employees and is provided to state and local government officials and employees;
- training provided to or developed and delivered under interagency agreements or cooperative arrangements with other Federal agencies.

DOE contractors, citizens, and other persons on an individual basis can only participate in training paid for with DOE Federal employee training funds (a) on a space-available basis, (b) if it will benefit DOE, and (c) when either direct statutory or contract authority exists to provide such training or participation at no material cost to DOE.

Training costs, contributions, awards, or services paid for by Internal Revenue Service designated 501(c)(3) nonprofit organizations may be accepted by employees after receiving approval in accordance with element policies and/or procedures.

**b. Explain how procurement requests are generated and approved for training services.**

The process for generating procurement requests traditionally has been decentralized, with the site office deferring to its own methods and guidance documents. Refer to your site's procurement professionals for assistance in the procurement process.

**c. State and discuss the requirements and limitations associated with open competition for services and products.**

The following is taken from 48 CFR 6.102.

The competitive procedures available for use in fulfilling the requirement for full and open competition are as follows:

- Contracting officers shall solicit sealed bids if
  - time permits the solicitation, submission, and evaluation of sealed bids;
  - the award will be made on the basis of price and other price-related factors;
  - it is not necessary to conduct discussions with the submitters about their bids;
  - there is a reasonable expectation of receiving more than one sealed bid.
- If sealed bids are not appropriate, contracting officers shall request competitive proposals or use
  - a combination of competitive procedures (e.g., two-step sealed bidding);
  - other competitive procedures (e.g., the selection of sources for architect-engineer contracts in accordance with the provisions of 40 U.S.C. 1102 et seq. is a competitive procedure [see subpart 36.6 for procedures]).
- Competitive selection of basic and applied research and that part of development not related to the development of a specific system or hardware procurement is a competitive procedure if award results from
  - a broad agency announcement that is general in nature, identifying areas of research interest, including criteria for selecting proposals, and soliciting the participation of all submitters capable of satisfying the government's needs;
  - a peer or scientific review.
- Use of multiple award schedules issued under the procedures established by the Administrator of General Services consistent with the requirement for the multiple award schedule program of the General Services Administration is a competitive procedure.

**d. Describe how the type of contract, such as performance-based contracts and fee-based contracts, affects the assessment and evaluation of a contract.**

The following is taken from DOE M 413.3-1.

*Performance-Based Contracts*

Performance-based service contracting emphasizes that all aspects of an acquisition be structured around the purpose of the work to be performed as opposed to the manner in which the work is to be performed. The contractors are given the freedom to determine how

to meet the government's performance objectives and achieve the appropriate performance quality levels. Payment is made only for services that meet these levels.

Performance-based contracting means structuring all aspects of an acquisition around the purpose of the work to be performed with the contract requirements set forth in clear, specific, and objective terms with measurable outcomes as opposed to either the manner by which the work is to be performed or broad and imprecise statements of work.

There are five elements of performance-based contracting:

- Statements of work
- QA
- Selection procedures
- Contract type
- Follow-on and repetitive requirements

At a high level, these are the activities that need to be developed, planned, and executed successfully within a given project and its procurements. From a project perspective, these elements are part of the plans and decision processes required as part of various project activities.

The following seven-step process is adapted from existing government information on performance-based contracting. It is important to note that integrated project teams need to be well-trained in performance-based contracting approaches and updated in lessons learned experiences that may be incorporated, in real time, into any project undertaking.

- Step 1. Establish an integrated project team. This is sometimes referred to as an integrated solutions team, since their fundamental purpose is to find performance-based solutions to agency mission and program needs.
- Step 2. Describe and develop the problem that needs to be solved and the link to the Department's strategic plan and objectives. A clear vision of the need and the requirements leads to the definition of what performance will be necessary to meet the requirements. A performance-based picture of the acquisition is to be the team's first goal. However, it is not yet time to retrieve the requirements from former solicitations, search for templates, think about the contract type or incentives, or decide on the contractor or the solution. This effort results in identifying a need and functional requirements and includes early preliminary planning documents such as the initial acquisition strategy, risk comparisons, and potential alternatives.
- Step 3. Examine the potential solutions from both private and public sectors. This is called market research, and it is a vital means of arming the team with the expertise needed to conduct an effective performance-based acquisition. The entire integrated project team needs to have a common understanding of what features (high-level objectives, functions, and constraints), schedules, terms, and conditions are crucial to the potential solution. Picking a specific solution is to be resisted and adequate planning time allowed to carry out the next two steps. This may include the entire project definition phase (selecting, preparing, and delivering the concept), or may be done during any phase as necessary to support a procurement. An example would be preparing for a conceptual design contract, technology development, or a site characterization effort.
- Step 4. Develop performance work statements for the work to be accomplished. This work statement is included in solicitations or in the work authorizations used to task

existing contractors. Let the contractor propose solving the problem, including the labor mix. This statement will satisfy the next step as well as the requirements of Office of Management and Budget, OMB A-11. Below this level, performance work statements and/or statement of objective documents are used as part of the request for proposals. The statement of objective is a very short document that provides the basic, high-level objectives of the acquisition. In this approach, the contractors' proposals contain statements of work and performance metrics and measures. Use of a statement of objectives opens the acquisition up to a wider range of potential solutions. For a large, complex project, this may take multiple contracts, but for a noncomplex project, it may be developed into one bid by a prime contractor and eventually performed by a single contractor.

- Step 5. Decide how to measure and manage performance. Measuring and managing performance is a complex process and requires the consideration of many factors. These factors include performance standards and measurement techniques, performance management approach, incentives, and more. Best practices in this area include relying on commercial quality standards, having the contractor propose the metrics and the quality assurance plan, considering the use of incentive tools, and selecting only a few meaningful measures on which to judge success. Progress is performance for which the contractor is responsible. Communicating progress for projects is one element of the earned value management system.
- Step 6. Select the right contractor(s). Bringing the acquisition strategy to fruition by executing the strategy and selecting the right contractor is especially important in performance-based contracting. The contractor must understand the functional and performance requirements and have the capability to fulfill them. The contractor must have technical skills, business and technical management capability, and the ability to integrate activities in complex endeavors. Finally, the contractor must have the support processes (safety, engineering, quality, procurement, etc.) and resources in place to support the Department's objectives and requirements.
- Step 7. Manage performance. During the project execution and transition/closeout phases, management systems are used to monitor, manage, and report performance. This includes appropriate reviews, performance measures, and reporting. Performance is not merely doing the work correctly; it is also doing the work using the proper procedures. While the Department may not direct how something is to be accomplished/achieved, there are statutes, standards, and regulations regarding work processes and the government's role in monitoring the performance of those processes.

### *Fee-Based Contracts*

Fixed-price types of contracts provide goods/services for a firm price or, in appropriate cases, an adjustable price. Fixed-price contracts providing for an adjustable price may include a ceiling price, a target price (including target cost), or both. Unless otherwise specified in the contract, the ceiling price or target price is subject to adjustment only by operation of contract clauses providing for equitable adjustment or other revision of the contract price under stated circumstances. The contracting officer should use firm-fixed-price or fixed-price with economic price adjustment contracts when acquiring commercial items.

A firm-fixed-price contract provides goods/services for a price that is not subject to any adjustment on the basis of the contractor's cost experience in performing the contract. This

contract type places upon the contractor maximum risk and full responsibility for all costs and resulting profit or loss. It provides maximum incentive for the contractor to control costs and perform effectively and imposes a minimum administrative burden upon the contracting parties. The contracting officer may use a firm-fixed-price contract in conjunction with an award-fee incentive and performance or delivery incentives when the award fee or incentive is based solely on factors other than cost. The contract type remains firm-fixed-price when used with these incentives.

A firm-fixed-price contract is suitable for acquiring commercial items or for acquiring other supplies or services on the basis of reasonably definite functional or detailed specifications when the contracting officer can establish fair and reasonable prices at the outset, such as when

- there is adequate price competition;
- there are reasonable price comparisons with prior purchases of the same or similar supplies or services made on a competitive basis or supported by valid cost or pricing data;
- available cost or pricing information permits realistic estimates of the probable costs of performance;
- performance uncertainties can be identified and reasonable estimates of their cost impact can be made, and the contractor is willing to accept a firm fixed price representing assumption of the risks involved.

**e. Describe the process for developing a scope of work, request for proposal, and evaluation criteria to determine the best source or provider of training services or products.**

*Scope of Work*

The following is taken from DOE, National Environmental Protection Agency (NEPA) Contracting Reform Guidance.

The scope or statement of work defines the services DOE is procuring. The statement of work is the Department's key direction to the contractor, and its specificity is critical to reducing costs while increasing the timeliness and quality of the training experience.

A statement of work forms the basis of the contracting officer's decisions on contract or task type (generally, fixed-price versus cost-reimbursement) and incentives to encourage attainment of desired outcomes and reward superior performance.

A statement of work should emphasize what the contractor is to accomplish rather than how the work is to be done.

A highly performance-specific statement of work permits prospective training contractors to price their offers more accurately and allows price competition to be effective. Vague statements of work will elicit vague proposals, with budgetary allowances to protect the submitter from underestimating the complexity or scope of the job. It then becomes harder for the source selection team to compare proposals on the basis of technical adequacy or value for cost. The greater the specificity, the better the potential fit to a fixed-price contract. Low specificity generally requires a cost-reimbursement type contract.



A statement of work may specify performance elements (for example, document quality, cost, and timeliness) that DOE wishes to link to incentives.

A clear, results-oriented statement of work facilitates DOE evaluation of contractor performance when the contract work is completed.

### *Request for Proposal*

The following is taken for the State of Delaware, What is a Request for Proposal?

A request for proposal (referred to as an RFP) is an invitation for suppliers, through a tender process, to bid on a specific product or service. An RFP is usually part of a complex sales process, also known as enterprise sales.

An RFP typically involves more than the price. Other requested information may include basic corporate information and history, financial information (can the company deliver without risk of bankruptcy), technical capability (used on major procurements of services, where the item has not previously been made or where the requirement could be met by varying technical means), product information such as stock availability and estimated completion period, and customer references that can be checked to determine a company's suitability.

RFPs often include specifications of the item, project, or service for which a proposal is requested. The more detailed the specifications, the better the chances that the proposal provided will be accurate. Generally, RFPs are sent to an approved supplier or vendor list.

The bidders return a proposal by a set date and time. Late proposals may or may not be considered, depending on the terms of the initial RFP. The proposals are used to evaluate the suitability as a supplier, vendor, or institutional partner. Discussions may be held on the proposals (often to clarify technical capabilities or to note errors in a proposal). In some instances, all or only selected bidders may be invited to participate in subsequent bids, or may be asked to submit their best technical and financial proposal, commonly referred to as a Best and Final Offer.

### *Evaluation Criteria*

The following is taken from DOE, NEPA Contracting Reform Guidance.

The source selection team should solicit information on all relevant dimensions of contractor performance, including:

- conformance of services to contract requirements (quality of reports, adequacy of correction of deficiencies).
- adequacy and effectiveness of contractor's quality assurance system.
- timeliness (including adherence to contract delivery schedules, resolution of delays).
- cost efficiency.
- reasonableness and cooperativeness.

The performance elements considered during source selection should correspond to the most important factors anticipated in the processes covered by the scope of work and, to the extent practicable, also should correspond to the performance elements on which DOE will evaluate the selected contractor.

Past performance information is subjective, in part, and must be interpreted and considered within the context of all other available data. The source selection team must judge the extent to which performance of previous contracts is likely to predict success under the contract contemplated, and assign an appropriate weight to this information. The Office of Management and Budget's Office of Federal Procurement Policy recommends that the past performance evaluation criteria in a solicitation be assigned at least 25 percent of the noncost evaluation factors or at least equal the weight assigned to other significant noncost evaluation factors, i.e., technical approach, qualifications of key management and technical personnel, planning and organization.

If an offeror has not had past performance relating to the solicitation, the source selection team will not evaluate the offeror favorably or unfavorably on this factor, and the offeror must receive a neutral evaluation for past performance. A solicitation should clearly identify how a lack of past performance will be evaluated.

**f. Conduct a cost-benefit review and analysis for the selection of one of two given vendor courses, and report the results.**

This is a performance-based KSA The Qualifying Official will evaluate its completion.

**17. Technical training personnel shall demonstrate a familiarity-level of knowledge of project management practices sufficient to manage training-related programs and projects.**

**a. Explain the purpose of project management and describe the life cycle of a typical project.**

*Project Management*

The following is taken from DOE *Project Management Career Development Program Implementation Guide for use with DOE Order 361.1A, Chapter IV Acquisition Career Development Program*. June 2005.

Project management is the application of KSAs to a variety of activities to successfully complete a project. In general, a project is a unique effort that supports a program mission, has defined start and end points, is undertaken to create a product, a facility, or a system, and contains interdependent activities planned to meet a common objective or an overall mission.

*Life Cycle of a Typical Project*

The following is taken from DOE O 413.3A.

The DOE acquisition management system establishes principles and processes to translate user needs and technological opportunities into reliable and sustainable facilities, systems, and assets that provide a required mission capability. The system is organized by project phases and critical decisions (CDs), which represent a logical maturing of broadly stated mission needs into well-defined requirements resulting in operationally effective, suitable, and affordable facilities, systems, and other products. Tailoring is an essential element of the acquisition process and shall be applied to all projects, although the greatest amount of tailoring will typically be applied to smaller, low-risk, and non-complex projects.

## Project Phases

Initiation Phase. During this phase, preconceptual planning activities focus on the Program's strategic goals and objectives. User needs are analyzed for consistency with the Department's strategic plan, Congressional direction, administration initiatives, and political and legal issues. One outcome of the analysis could be a determination that a user need exists that cannot be met through other than material means. This outcome leads to the development and approval of a mission need statement. The information developed during this phase also provides the basis for the project engineering and design budget request when preliminary design activities are planned.

Definition Phase. Upon approval of mission need, the project enters the definition phase where alternative concepts, based on user requirements, risks, costs, and other constraints, are analyzed to arrive at a recommended alternative. This is accomplished using systems engineering and other techniques and tools such as alternatives analysis and value management/value engineering. This ensures the recommended alternative provides the essential functions and capability at optimum life cycle cost, consistent with required performance, scope, schedule, cost, security, and environment, safety, and health considerations. During this phase, the required value management assessment is completed, and more detailed planning is accomplished which further defines required capabilities. The products produced by this planning provide the detail necessary to develop a range of estimates for the project cost and schedule.

Execution Phase. Following the definition phase, preliminary design activities mark the beginning of the execution phase. Systems engineering continues to balance requirements, cost, schedule, and other factors to optimize the design, cost, and capabilities that satisfy the mission need. Engineering and design continue until the project has a sufficiently mature design that can be implemented successfully within a firm performance baseline. During this phase, the initial design concepts and the preliminary design are developed into detailed and final designs and plans. These plans are used to procure or manufacture components, fabricate subsystems, or construct, remediate, decommission or demolish facilities.

## Critical Decisions

The five CDs are major milestones approved by the Secretarial Acquisition Executive (SAE) or Acquisition Executive that establish the mission need, recommended alternative, acquisition strategy, the performance baseline, and other essential elements required to ensure that the project meets applicable mission, design, security, and safety requirements. Each CD marks an increase in commitment of resources by the Department and requires successful completion of the preceding phase or CD. Collectively, the CDs affirm the following:

- There is a need that cannot be met through other than material means.
- The selected alternative and approach is the optimum solution.
- Definitive scope, schedule and cost baselines have been developed.
- The project is ready for implementation.
- The project is ready for turnover or transition to operations.

The amount of time between decisions will vary. Projects may quickly proceed through the early CDs due to a lack of complexity, the presence of constraints that reduce available

alternatives, or the absence of significant technology and developmental requirements. In these cases, more than one CD may be approved simultaneously. Conversely, there may be a need to split a CD.

CD-0, Approve Mission Need. The initiation phase begins with the identification of a mission-related need. A program identifies a credible performance gap between its current capabilities and capacities and those required to achieve the goals articulated in its strategic plan and/or in the DOE target enterprise architecture for information technology capital asset projects. A mission need statement is the translation of this gap into functional requirements that cannot be met through other than material means. It should describe the general parameters of the project, how it fits within the mission of the program, and why it is critical to the overall accomplishment of the Department mission, including the benefits to be realized. The mission need is independent of a particular solution, and should not be defined by equipment, facility, technological solution, or physical end-item. This approach allows the program the flexibility to explore a variety of solutions and not limit potential solutions. Approval of CD-0 formally establishes a project and begins the process of conceptual planning and design used to develop alternative concepts and functional requirements. Additionally, CD-0 approval allows the program to request project engineering and design funds for use in preliminary design, final design, and baseline development.

CD-1, Approve Alternative Selection and Cost Range. CD-1 approval marks the completion of the project definition phase, during which time the conceptual design is developed. This is an iterative process to define, analyze, and refine project concepts and alternatives. This process uses a systems methodology that integrates requirements analysis, risk identification and analysis, acquisition strategies, and concept exploration to evolve a cost-effective, preferred solution to meet a mission need. Approval of CD-1 provides the authorization to begin the project execution phase and allows project engineering and design funds to be used. For design-build projects, project engineering and design funds may be used to develop a statement of work/request for proposal. Additionally, long-lead procurements may be approved during this phase, provided NEPA documentation is prepared, where applicable.

CD-2, Approve Performance Baseline. Completion of preliminary design is the first major milestone in the project execution phase. Preliminary design is complete when it provides sufficient information for development of the performance baseline in support of CD-2. The performance baseline is developed based on a mature design, a well-defined and documented scope, a resource-loaded detailed schedule, a definitive cost estimate, and defined key performance parameters. Approval of CD-2 authorizes submission of a budget request for the total project cost. For projects with design periods less than 18 months, a budget request may be submitted prior to CD-2 approval as part of tailoring.

CD-3, Approve Start of Construction. With design and engineering essentially complete, a final design review performed, all environmental and safety criteria met, and all security concerns addressed, the project is ready to begin construction, implementation, procurement, or fabrication. CD-3 provides authorization to complete all procurement and construction and/or implementation activities and initiate all acceptance and turnover activities. Approval of CD-3 authorizes the project to commit all the resources necessary, within the funds provided, to execute the project.

CD-4, Approve Start of Operations or Project Completion. CD-4 marks the achievement of the completion criteria defined in the project execution plan and approval of transition to operations. This decision is predicated on the readiness to operate and/or maintain the system, facility, or capability. Transition and turnover does not necessarily terminate all project activity. Rather, it marks a point at which the operations organizations assume responsibility for operation and maintenance. All projects must have a project transition/closeout plan that clearly defines the basis for attaining initial or full operating capability or meeting performance criteria as required for project closeout, as applicable. The key attributes in turnover are the government's readiness to operate, the ability to assume operational responsibility, and the acceptance of the asset.

**b. Describe the applicable federal rules and regulations, along with the typical documents and data sources used in project management.**

*Federal Rules and Regulations*

The following is taken from the U.S. General Services Administration, Regulatory Reference Overview.

The Federal Acquisition Regulation (FAR) is the primary regulation for use by all Federal executive agencies in their acquisition of supplies and services with appropriated funds. It became effective on April 1, 1984, and is issued within applicable laws under the joint authorities of the Administrator of General Services, the Secretary of Defense, and the Administrator for the National Aeronautics and Space Administration, under the broad policy guidelines of the Administrator, Office of Federal Procurement Policy, Office of Management and Budget.

The FAR precludes agency acquisition regulations that unnecessarily repeat, paraphrase, or otherwise restate the FAR, limits agency acquisition regulations to those necessary to implement FAR policies and procedures within an agency, and provides for coordination, simplicity, and uniformity in the Federal acquisition process. It also provides for agency and public participation in developing the FAR and agency acquisition regulation.

The following is taken from DOE, Department of Energy Acquisition Regulation.

The Department of Energy Acquisition Regulation (DEAR) implements and supplements the FAR and is not, by itself, a complete document; it must be used in conjunction with the FAR. The DEAR is divided into the same parts, subparts, sections, subsections and paragraphs as is the FAR. However, when the FAR coverage is adequate by itself, there will be no corresponding DEAR part, subpart, etc.

*Typical Documents*

The following is taken from DOE O 413.3A.

*Performance Baseline*

The performance baseline, as established in the project execution plan, defines the cost, schedule, performance, and scope commitment to which the Department must execute a project. When the development effort has reached a phase where the requirements and design

are mature and the uncertainty and risks have been eliminated, reduced, mitigated, or accepted a project is able to establish the parameters within which it will be executed. These key parameters, when completely identified, define the performance baseline. The performance baseline includes the entire project budget and represents DOE's commitment to the Congress and the Office of Management and Budget. The performance baseline must be controlled, tracked, and reported from the beginning to the end of a project to ensure consistency between the project execution plan, the project data sheet, and the exhibit 300 (a requirement of Office of Management and Budget Circular A-11, Part 7).

#### Project Execution Plan

The project execution plan is the core document for management of a project. The Federal project director is responsible for the preparation of this document. It establishes the policies and procedures to be followed to manage and control project planning, initiation, definition, execution, and transition/closeout, and uses the outcomes and outputs from all project planning processes, integrating them into a formally approved document. A project execution plan includes an accurate reflection of how the project is to be accomplished, resource requirements, technical considerations, risk management, configuration management, and roles and responsibilities. A preliminary project execution plan is required to support CD-1. This document continues to be refined throughout a project's life cycle and revisions are documented through the configuration management process.

#### Mission Need Statement

A concise document that details a mission requirement the Department cannot meet through nonmaterial method.

#### **c. Identify and explain the major elements of a project, and discuss their relationship.**

The following is taken from DOE M 413.3-1.

The acquisition management system establishes a management process to translate user needs and technological opportunities into reliable and sustainable facilities, systems, and assets that provide the required mission capability. The system is organized by phases and critical decisions. The Deputy Secretary serves as the SAE for the Department. As the SAE, he/she promulgates Department-wide policy and direction, and personally makes critical decisions for major system projects. Designated acquisition executives make critical decisions for non-major system projects. The phases represent a logical maturing of broadly stated mission needs into well-defined technical, system, safety, and quality requirements, and ultimately into operationally effective, suitable, and affordable facilities, systems, and other end products.

#### *Initiation Phase*

During the initiation phase, identified user needs are analyzed for consistency with the Department's strategic plan, congressional direction, administration initiatives, and political and legal issues. One outcome of the analysis could be a determination that a user need exists that cannot be met through other than material means. This outcome leads to the development and approval of a mission need statement that discusses the user need in terms

of required capability, and not equipment, facilities, or other specific products. This is the first critical decision of the acquisition process: to approve mission need. The information developed during this phase also provides the basis for the project engineering and design budget request when preliminary design activities are planned.

#### *Definition Phase*

Upon approval of mission need, the project enters the definition phase, where alternative concepts based on user requirements, risks, costs, and other constraints are analyzed to arrive at a recommended alternative. This is accomplished using systems engineering and other techniques and tools, such as alternatives analysis and value management, to ensure the recommended alternative provides the essential functions and capability at the optimum life-cycle cost, consistent with required performance, scope, schedule, and cost. During this phase, more detailed planning is accomplished which further defines the required capability. These efforts include conceptual design, requirements definition, risk analysis and management planning, and development of the acquisition strategy. The products produced by this planning provide the detail necessary to develop a rough order of magnitude or range for the project cost and schedule. The recommended alternative, when sufficiently defined and analyzed, is presented to the SAE or designated acquisition executive for review and approval.

#### *Execution Phase*

Upon completing the definition phase, the project enters the execution phase where the focus is on further defining the selected alternative, developing preliminary designs, arriving at a high-confidence baseline, and generating the complete project execution plan, all of which support a request for funds in the DOE budget. This part of the execution phase culminates with the development of the performance baseline, which is presented to the SAE or designated acquisition executive for approval. The performance baseline documents the Department's commitment to Congress to execute the project at a specific cost and schedule threshold and achieve a specific performance capability. After CD-2, engineering and design continue until the project is ready for construction or implementation. Before major budget and other resources for construction or implementation are committed, an executability review is performed as a precursor to CD-.

#### *Transition/Closeout Phase*

The transition/closeout phase is when the project is approaching completion and has progressed into formal transition, which generally includes final testing, inspection, and documentation, as the project is prepared for operation, long-term care, or closeout. Once implementation is substantially complete, transition to operations begins. The transition point will depend on the type of project. A project may seek approval to transition to operations when required capability is implemented and functioning, and operational resources are in place, have been trained, and are able to perform their continuing responsibilities.

To execute its missions, the Department organizes related and interdependent mission elements into programs. Programs may be composed of ongoing operational activities with no set duration periods, acquisition activities with specific durations, or combined acquisition and operational programs. An operational activity is typically identified by multi-year activities that use relatively straight-line funding over an extended period of time and work

planning that is normally accomplished for each year. Acquisition projects are structured to deliver defined capabilities within fixed time frames and costs, and tend to have funding plans that peak in the middle of the project with a corresponding slope as the project progresses to completion. Planning for acquisition projects normally is multi-year from start to completion.

A program is an organized set of activities directed toward a common purpose, objective, or goal undertaken or proposed by an agency to carry out assigned responsibilities. The term is generic and may be applied to many types of activities. Acquisition programs are programs whose purpose is to deliver a capability in response to a specific mission need. Acquisition programs may comprise multiple acquisition projects and other activities necessary to meet the mission need.

Projects are specific undertakings that support a program mission, are undertaken to create a product, facility, or system, and have defined beginning and end points. DOE projects range from relatively simple vertical construction of a building to developing, designing, and implementing large, complex, one-of-a-kind systems made up of multiple subsystems that require the integration of multiple locations and systems into a unified whole. Projects also include developing and installing software systems, remediation and disposition of contaminated sites and facilities, and restoration or modernization of existing facilities and infrastructure. Most projects are characterized as a collected set of overlapping, interdependent activities. For example, design may be ongoing in one project area, while in another project area, items may be in construction or testing.

**d. Explain the purpose and use of a project management plan.**

The following is taken from DOE O 413.3A.

The project management plan, also called the project execution plan, is the primary agreement on project planning and objectives between the HQ program office and the field that establishes roles and responsibilities and defines how the project will be executed. The project execution plan, once approved, becomes a significant tool for the project manager through the life of the project. The HQ or field program manager and/or the Federal project manager initiate a project execution plan.

Development of the preliminary project execution plan can be started by the prime contractor at the same time as development of the acquisition plan, or shortly thereafter. The two plans should be synchronized. If the approved acquisition plan indicates that the contractor has a role in the acquisition of the project as prime contractor/integrator, the contractor may participate with DOE in development of the final project execution plan.

**e. Discuss the relationship between a work breakdown structure (WBS) and the cost and schedule.**

The following is taken from DOE G 430.1-1, chapter 5.

A WBS shows the relationship of all elements of a project. This provides a sound basis for cost and schedule control. During that period of a project's life from its inception to a



completed project, a number of diverse financial activities must take place. These activities include cost estimating, budgeting, accounting, reporting, controlling and auditing. A WBS establishes a common frame of reference for relating job tasks to each other and relating project costs at the summary level of detail.

Since the WBS divides the package into work packages, it can also be used to interrelate the schedule and costs. The work packages or their activities can be used as the schedule's activities. This enables resource loading of a schedule, resource budgeting against time, and the development of a variety of cost budgets plotted against time.

**f. Describe the purpose of schedules, and discuss the use of milestones and activities.**

The following descriptions are taken from DOE G 430.1-1, chapter 12.

*Schedules*

The schedule is one of the building blocks for project development. A schedule helps determine the duration of the project, the critical activities, and when funds are required.

*Milestones*

Project milestones are called key decisions at DOE. They are as follows.

**Key Decision 0 (KD-0) - Approval of Mission Need**

- Prerequisite for requesting conceptual design funding in the internal review budget cycle.
- Approval must occur prior to the planning stages of the annual internal review budget cycle and submission of initial funding requests to Office of Management and Budget and Congress.
- Documentation Requirement: justification of mission need.
- Prerequisite for release of appropriated funding by the Chief Financial Officer (CFO).

**Key Decision 1 (KD-1) - Approval of New Start**

- Prerequisite for requesting project line item funding in the internal review budget cycle.
- Approve project plan, including initial project baselines. Initial technical cost and schedule baselines for the project will be based on the conceptual design report and its support documentation.
- Implement a change control system delineating specific responsibilities, authority, and accountability at the appropriate management levels for changes affecting the project baselines.
- Other input to the decision process includes completion of the budget validation, the independent cost estimate, and the project data sheet.
- Prerequisite for release of appropriated funding by the CFO.

**Key Decision 2 (KD-2) - Approval to Commence Title II, or Final/Detailed Design**

- Scheduled prior to start of title II or final/detailed design as identified in data sheet.
- Input to decision process includes update to the project baselines reflecting completion of preliminary design and an independent cost estimate (ICE).

- Current project plan reflecting approved baseline changes, as appropriate.
- Approval to begin long-lead procurement, if applicable.
- Prerequisite for release of appropriated funding by the CFO.

#### Key Decision 3 (KD-3) - Approval to Commence Construction or Enter Full-Scale Development

- Scheduled prior to date in approved project plan schedule for starting construction or entering full-scale development.
- Input to decision process is evidence of readiness to proceed, appropriateness of timing, and firm baseline and includes the update of project baselines reflecting the completion of final/detailed design (title II) and an ICE.
- Current project plan reflects the approved baseline changes, as appropriate.
- Prerequisite for release of appropriated funding by the CFO.

#### Key Decision 4 (KD-4) - Approval to Commence Operation/Production

- Scheduled prior to date in approved project plan schedule for transition from acquisition to operation/production; transition is not formally made until demonstrated capability to meet technical performance goals approved in baseline.
- Input to decision process is evidence of operational readiness.
- Prerequisite for release of appropriated funding by the CFO.

#### *Activities*

The activities from a work breakdown structure become the building blocks for a schedule. An activity is any specific element of work. It is important that activities not be confused with schedule events. Events are indicators of the beginning or completion of an activity. An event milestone is usually one specific point in time, whereas an activity occurs over a period of time.

#### **g. Describe the critical path method of scheduling.**

The following is taken from the Massachusetts Institute of Technology, Network Models.

The critical-path method (CPM) is a project-management technique that is used widely in government and industry to analyze, plan, and schedule the various tasks of complex projects. CPM is helpful in identifying which tasks are critical for the execution of the overall project, and in scheduling all the tasks in accordance with their prescribed precedence relationships so that the total project completion date is minimized, or a target date is met at minimum cost.

Typically, CPM can be applied successfully in large construction projects, like building an airport or a highway; in large maintenance projects, such as those encountered in nuclear plants or oil refineries; and in complex research-and-development efforts, such as the development, testing, and introduction of a new product. All these projects consist of a well specified collection of tasks that should be executed in a certain prescribed sequence. CPM provides a methodology to define the interrelationships among the tasks, and to determine the most effective way of scheduling their completion.

Although the mathematical formulation of the scheduling problem presents a network structure, this is not obvious from the outset. Consider the scheduling of tasks involved in building a house on a foundation that already exists. We would like to determine in what sequence the tasks should be performed in order to minimize the total time required to execute the project. All we know is how long it takes to carry out each task and which tasks must be completed before commencing any particular task. In fact, it will be clear that we need only know the tasks that immediately precede a particular task, since completion of all earlier tasks will be implied by this information. The tasks that need to be performed in building this particular house, their immediate predecessors, and an estimate of their duration are given in table 2.

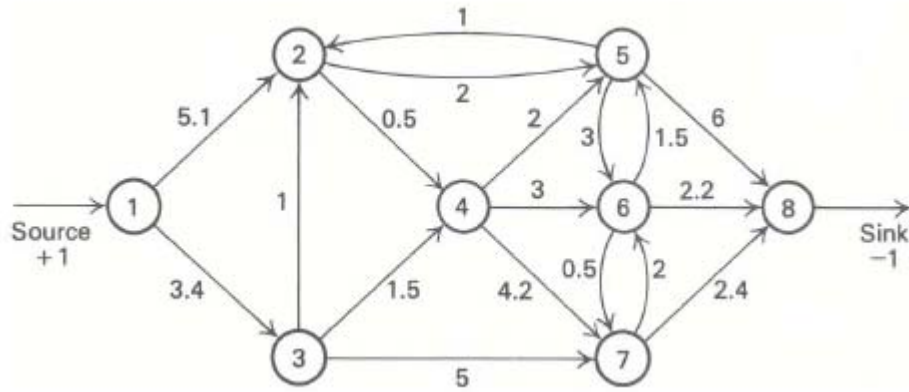
**Table 2.** Task and precedence relationships

No.	Task	Immediate predecessors	Duration	Earliest starting times
0	Start	—	0	—
1	Framing	0	2	$t_1$
2	Roofing	1	1	$t_2$
3	Siding	1	1	$t_2$
4	Windows	3	2.5	$t_3$
5	Plumbing	3	1.5	$t_3$
6	Electricity	2,4	2	$t_4$
7	Inside Finishing	5,6	4	$t_5$
8	Outside Painting	2,4	3	$t_4$
9	Finish	7,8	0	$t_6$

*Source:* Massachusetts Institute of Technology, Network Models.

It is clear that there is no need to indicate that the siding must be put up before the outside painting can begin, since putting up the siding precedes installing the windows, which precedes the outside painting. It is always convenient to identify a “start” task, that is, an immediate predecessor to all tasks, which in itself does not have predecessors; and a “finish” task, which has, as immediate predecessors, all tasks that in actuality have no successors.

Although it is by no means required to perform the necessary computations associated with the scheduling problem, often it is useful to represent the interrelations among the tasks of a given project by means of a network diagram. In this diagram, nodes represent the corresponding tasks of the project, and arcs represent the precedence relationships among tasks. The network diagram for this example is shown in figure 6.



Source: Massachusetts Institute of Technology, Network Models

**Figure 6.** Task oriented network

There are nine nodes in the network, each representing a given task. For this reason, this network representation is called a task- (or activity-) oriented network.

Assume that the objective is to minimize the elapsed time of the project. A linear programming problem can be formulated. First, define the decision variables  $t_i$  for  $i = 1, 2, \dots, 6$ , as the earliest starting times for each of the tasks. Table 2 gives the earliest starting times where the same earliest starting time is assigned to tasks with the same immediate predecessors.

For instance, tasks 4 and 5 have task 3 as their immediate predecessor. Obviously, they cannot start until task 3 is finished; therefore, they should have the same earliest starting time. Letting  $t_6$  be the earliest completion time of the entire project, the objective is to minimize the project duration given by

$$\text{Minimize } t_6 - t_1,$$

subject to the precedence constraints among tasks. Consider a particular task, say 6, installing the electricity. The earliest starting time of task 6 is  $t_4$ , and its immediate predecessors are tasks 2 and 4. The earliest starting times of tasks 2 and 4 are  $t_2$  and  $t_3$ , respectively, while their durations are 1 and 2.5 weeks, respectively. Hence, the earliest starting time of task 6 must satisfy:

$$\begin{aligned} t_4 &\geq t_2 + 1 \\ t_4 &\geq t_3 + 2.5 \end{aligned}$$

In general, if  $t_j$  is the earliest starting time of a task,  $t_i$  is the earliest starting time of an immediate predecessor, and  $d_{ij}$  is the duration of the immediate predecessor, then we have:

$$t_j \geq t_i + d_{ij}$$

For our example, these precedence relationships define the linear program given in table 3.

**Table 3.** Linear program

$t_1$	$t_2$	$t_3$	$t_4$	$t_5$	$t_6$	Relation	Right-hand side
-1	1					$\geq$	2
	-1	1				$\geq$	3
	-1		1			$\geq$	1
		-1	1			$\geq$	2.5
		-1		1		$\geq$	1.5
			-1	1		$\geq$	2
			-1		1	$\geq$	3
				-1	1	$\geq$	4
-1					1	$=$	$T$ (min)

Source: Massachusetts Institute of Technology, Network Models

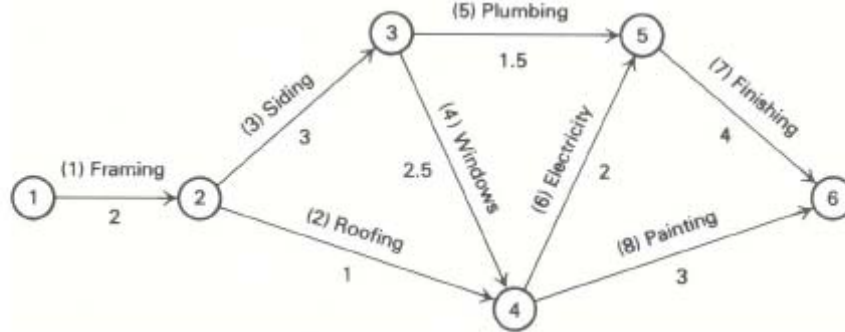
We do not yet have a network flow problem; the constraints of (5) do not satisfy our restriction that each column have only a plus-one and a minus-one coefficient in the constraints. However, this is true for the rows, so let us look at the dual of (5). Recognizing that the variables of (5) have not been explicitly restricted to the nonnegative, we will have equality constraints in the dual. If  $x_{ij}$  is the dual variable associated with the constraint of (5) that has a minus one as a coefficient for  $t_i$  and a plus one as a coefficient of  $t_j$ , the dual of (5) is then given in table 4.

**Table 4.** Linear program

$x_{12}$	$x_{23}$	$x_{24}$	$x_{34}$	$x_{35}$	$x_{45}$	$x_{46}$	$x_{56}$	Relation	Right-hand side
-1								$=$	-1
1	-1	-1						$=$	0
	1		-1	-1				$=$	0
		1	1		-1	-1		$=$	0
				1	1		-1	$=$	0
						1	1	$=$	1
2	3	1	2.5	1.5	2	3	4	$=$	$z$ (max)

Source: Massachusetts Institute of Technology, Network Models

Note that each column of (6) has only one plus-one coefficient and one minus-one coefficient, and hence the table describes a network. If we multiply each equation through by minus one, we will have the usual sign convention with respect to arcs emanating from or incident to a node. Further, since the right hand side has only a plus one and a minus one, we have flow equations for sending one unit of flow from node 1 to node 6. The network corresponding to these flow equations is given in figure 7; this network maintains the precedence relationships from table 2. Observe that we have a longest-path problem, since we wish to maximize  $z$ .



Source: Massachusetts Institute of Technology, Network Models

**Figure 7.** Event oriented network

Note that, in this network, the arcs represent the tasks, while the nodes describe the precedence relationships among tasks. This is the opposite of the network representation given in figure 6. The network of figure 7 contains 6 nodes, which is the number of sequencing constraints prescribed in the task definition of table 2 since only six earliest starting times were required to characterize these constraints. Because the network representation of figure 7 emphasizes the event associated with the starting of each task, it is commonly referred to as an event-oriented network.

There are several other issues associated with critical-path scheduling that also give rise to network-model formulations. In particular, one can consider allocating funds among the various tasks to reduce the total time required to complete the project. The analysis of the cost-vs.-time tradeoff for such a change is an important network problem. Broader issues of resource allocation and requirements smoothing can also be interpreted as network models, under appropriate conditions.

## Selected Bibliography and Suggested Reading

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