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# Standard Guide for Developing Training Programs in the Nuclear Fuel Cycle<sup>1</sup>

This standard is issued under the fixed designation C 986; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

 $\epsilon^1$  Note—Keywords were added editorially in June 1995.

#### 1. Scope

1.1 This guide covers a systematic process for the development of training programs. This approach is recommended for use within the nuclear fuel cycle. However, the steps described can be beneficially applied to the development of other technical training programs. It is particularly valuable for promoting the efficiency and safety of a complex technical operation.

1.2 This guide provides a description of the activities to be considered in developing effective training programs. It is written from the viewpoint of an industrial user. The approach is based on an operating organization (company) using its resources to develop training programs to meet that company's specific needs.

1.3 The responsible organization or individual who would perform the activities described will differ due to the unique variability in organizational structures of those applying the process. This is, therefore, not addressed in this guide. It is also not within the scope of this guide to prescribe the specific method for performing the activities.

1.4 There are many associated activities and decisions not considered such as training facility design, audio-visual resources, and documentation systems. However, to reduce the possibility of oversight, it is recommended that the user refer to "A Checklist for Technical, Skills, and Other Training."

#### 2. Referenced Documents

2.1 American Society for Training and Development Document:

A Checklist for Technical, Skills, and Other Training<sup>2</sup>

#### 3. Terminology

3.1 Descriptions of Terms and Symbols Specific to this Standard:

3.1.1 The following terms are presented in hierarchical order:

3.1.2 *programs*—the total accumulation of training activities that prepares an individual to perform the defined duties of a particular job (that is, reactor operator).

3.1.3 *courses*—the specific portions of a training program that are designed to present certain job duties or core knowledge important to the job (that is, radiation safety, reactor cooling system).

3.1.4 *units*—the subdivisions of training courses where certain subjects related to specific duties are presented (that is, radiation self-survey, primary coolant flow).

3.1.5 *lessons*—the component parts of a course unit that present individual subject material (that is, the Geiger-Müeller counter, the PC-1 coolant pump).

3.1.6 *job analysis*—the examination of a job to determine the duties, tasks, and associated activities performed in a job. The results are lists that clearly define the job in terms of what is done.

3.1.7 *task analysis*—the systematic examination of exactly what is done when performing a task (the action steps, operations, or elements), the conditions under which it is performed, and the standards for adequate performance. The product of this is a detailed description of exactly what the employee must do and how it is done.

#### 4. Significance and Use

4.1 The purpose of this guide is to outline a generic process for development of training programs which meet the demanding requirements of the nuclear fuel cycle. The application of this process is intended to promote a training program that will be thorough, effective, and efficient in providing the knowledge and skill required for the job at hand.

4.2 The product of the overall process is a training program. Several of the steps in the process result in tangible elements that can document the process and provide a basis for independent review of the development efforts. This allows assessment of the completeness and applicability of the training program.

4.3 The process steps described here should comprise all the needed elements for an accreditable/auditable training program. However, the depth of detail pursued by an organization

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is a company management decision based on individual/ industry needs, standards, governmental requirements, etc.

#### 5. Understanding the Process Description

5.1 This guide outlines a process that is divided into five major activities as diagrammed in Fig. 1. When these activities are incorporated into a dynamic training program, the ultimate objective, competent employees, will be achieved. While a sequencing is apparent, there are feedback loops throughout the process so that the program can be readily revised to fulfill any changing requirement.

5.2 The component activities are dealt with in more detail in the following section utilizing detailed diagrams for clarity. The diagrams shown in Figs. 2-6 use standard precedence logic in a vertical format with a succeeding event below those that precede it. As an additional aid to clarity, the diagrams have the activities coded to the section within this guide where they are discussed.

5.3 Many activities result in tangible products that can serve to document the activity. When this is the case, these are recommended for inclusion in the overall program documentation.

#### 6. Process Description

6.1 Program Definition—This major activity is diagrammed

in detail in Fig. 2. Program definition provides the framework for all activities that follow. Careful attention to the overall intent of the training effort makes its achievement far more likely.

6.1.1 *Define Program Goals*—Training program should have goals pertaining to the overall purpose of the program. These defined goals should represent an extension of com-pany policy and reflect laws and regulations with respect to training. Goal statements serve the following purposes:

6.1.1.1 Clarify what is to be accomplished through the program,

6.1.1.2 Provide a basis for communicating program intent to trainees, management, and others,

6.1.1.3 Establish criteria for measuring the value of development efforts that follow, that is, determining whether this activity is necessary or effective in meeting the program goal, and

6.1.1.4 Provides assessment of how this program fits into the overall company training effort.

6.1.2 *Perform Job Analysis*—A job analysis produces detailed lists of tasks performed by the workers. This provides a foundation for the content and quality of program development. The result is a description of the job essential to planning and scoping the course content and the development efforts that





follow. This serves to do the following:

6.1.2.1 Define what the worker does on the job, and

6.1.2.2 Determine how work activities are conducted and managed, products are produced and distributed, and how services are provided. These tasks must be carefully identified with the job title of the worker to assure that the resulting instruction provides workers with knowledge and skills for the job they actually perform.

6.1.3 *Determine Program Objective*—Program objectives should be developed that will provide a specific description of the training program criteria. As a minimum, this should include the following:

6.1.3.1 Who is to receive instruction. (It can be valuable to state physical requirements, entry level experience, and aptitude. These may become at least part of the criteria for trainee selection.),

6.1.3.2 The job assignment where the training will be applied,

6.1.3.3 The knowledge and skill the trainee should possess upon completion of the program, that is, "mathematics sufficient to perform data analysis," and

6.1.3.4 General employment conditions that may include reference to physical, time, and operational conditions.

6.1.3.5 The program objectives should reflect the job requirements that were identified in the job analysis. A comparison should be made between the objectives and the identified tasks and any incongruities resolved.

6.1.4 *Identify Courses*—Courses that support the program objectives should be identified. These courses represent the first division of the overall program into more manageable parts. Generally, courses support specific skill or knowledge objectives of the program either from a subject viewpoint (mathematics), a process viewpoint (emergency shutdown), or a system viewpoint (ventilation).

6.1.5 *Identify Probable Course Sequence*—This produces an outline of the training program. The sequence logic should be evident and provide definition of prerequisite course requirements. Care in this step can avoid duplication of effort in the various courses.

6.1.6 *Repeat for Sublevels*—In Section 3, a training program was broken down into three levels of successively increasing detail. In order, these are courses, units, and lessons. In Section 6, the units appear to be omitted. This is not an oversight. The number of successive levels of detail varies with the complexity of the total program. In simple cases, only two sublevels may be necessary, where very complex programs may require more than the three shown here. In any case, the term, lesson, generally refers to the greatest level of detail from which specific instruction is conducted. The development approach shown for course development should be applied to



FIG. 3 Program Development

each intermediate level of detail (only units are identified in this guide). The process is then a repeat of the three steps 6.1.3, 6.1.4, and 6.1.5. For a sublevel of courses called units, this would do the following:

6.1.6.1 Determine course objectives,

- 6.1.6.2 Identify units, and
- 6.1.6.3 Identify probable unit sequence.

6.1.7 Then, moving on to program development 6.2, the first step, 6.2.1, would now be develop unit objectives—conduct task analysis.

6.2 *Program Development*—This activity is diagrammed in Fig. 3. Program Development is the process activity in which desired results of the program are developed, the presentation structure is designed, the resources necessary for program delivery are identified, and the student and instructor aids are produced.

6.2.1 *Develop Course Objectives–Conduct Task Analysis*— The program definition activity defined the broad program goals and objectives and provided a job analysis to identify the tasks which are involved in a worker's job. In this step, task analyses are performed to systematically examine these tasks and identify the steps, operations, and elements involved. This information is an essential foundation for the instruction to be developed. It is these steps, operations, and elements that the employee must be able to perform as a result of training. 6.2.1.1 In many cases other company organizations such as process engineering may have conducted an analysis sufficient to write step by step procedures for performing tasks. It is often in areas where such procedures (or analyses) do not exist that task analysis is most beneficial, for example, a new activity or an activity not adequately covered by procedures.

6.2.1.2 It is important that all tasks need not be analyzed in order to move on to further development steps. Some of these activities can be conducted in parallel. In addition, the degree of application and the detail of task analysis should be a function of the importance of the task, its complexity or difficulty, and how often it is performed.

6.2.1.3 Each course identified in 6.1.4 should have clearly identified objectives that correspond to the program goals and objectives but represent a "tighter" focus at a finer level of detail. Course objectives should be evaluated against the job task analyses, verifying that the objectives identified are relevant. Only those objectives that are valid for job-related tasks should be considered in program development. Course objectives can be identified in response to questions patterned after the following: (1) What is the change in knowledge desired from this course?, (2) What is the change in skill desired from this course? Clearly stated course objectives, referenced to elements from a task analysis, provide an



FIG. 4 Program Delivery

essential component of the program documentation.

6.2.2 Identify Lessons Required to Support Course Objectives—A systematic approach to training program development implies increasing detail as the instructional focus becomes tighter. Lesson segments that support related course objectives accomplish this and can be determined when the course objectives have been developed. Lessons are considered to be the discrete instructional parts that comprise a course.

6.2.2.1 Lessons should be identified in relation to course objectives. This is not to say that each lesson must accomplish a specific objective; rather, lessons should be identified from the objectives and contribute toward the achievement of one or more objectives. Prerequisite knowledge or skill necessary to achieve an objective should be considered when identifying lessons.

6.2.3 *Identify Probable Lesson Sequence*—The sequence for presentation of lessons should be determined after the lessons have been identified. A logical sequence of lessons leading toward fulfillment of the course objectives forms a course "outline" which should be included in the program documentation. The course outline will provide a useful tool in following development activities.

6.2.4 Develop Lesson Objectives-Lesson objectives tighten the focus of the development activity further and

provide the basis for lesson plan development. The same questions used to develop course objectives can be used for lesson objectives; however, the level of detail is greater for lesson objectives and the range of inquiry is restricted to the boundaries of the lesson.

6.2.4.1 Course objectives are often replicated among the lesson objectives. Lessons that do not directly fulfill a course objective should have lesson objectives identified that contribute to the course objectives. These should indicate the attainment of desired knowledge or skills that may be prerequisites necessary for successful completion of future lessons.

6.2.5 *Identify Required and Available Resources*—The specifications that describe the desired results of a training program, the components required to achieve those results, and the depth of instruction necessary in each component have been provided by the preceding program development activities. The developmental effort remaining in program development involves researching and writing the lesson plans which describe the final level of detail for instructional presentations. An interim planning activity remains to be performed prior to lesson plan development, however. The human and material resources necessary to perform the lesson plan activity should be identified.



6.2.5.1 The knowledge and experience required in an individual to develop a lesson that conforms to the program, course, and lesson objectives should be identified. The required qualifications of the instructional staff presenting the lesson should also be identified (essential for 6.3.1). The material resources such as reference documents, available training aids to support the lesson, and audio-visual equipment available to the instructor must be identified. The instructional resources, the training environment, and con-ditions under which a lesson will be delivered must be defined prior to lesson plan development since these factors determine the boundaries within which the lesson must be designed.

6.2.6 *Develop Lesson Plans*—Lesson plans represent the body of a training program. Lesson plans supply the significant instructional data to be provided during the lesson. Lesson plans also allow continuity and uniformity of information or skill transfer, or both, between repeated presentations of the same lesson by different instructors. The level of detail and required conformity to lesson plan steps will vary with different applications and different organizations. All lesson plans should incorporate, however, the components, as follows:

6.2.6.1 Record of revision,

6.2.6.2 Record of references used to develop lesson plan,

6.2.6.3 Resources required for lesson presentation,

6.2.6.4 Lesson objectives, and

6.2.6.5 Major elements of lesson (significant data or activities).

6.3 *Program Delivery*—This major activity is diagrammed in detail in Fig. 4. Program delivery involves both those activities involved in and closely related to the actual presentation of training sessions. This includes assuring adequate instructional and facility resources, employee scheduling, and the training event itself.

6.3.1 Select/Train Instructors—Care should be taken to ensure that there are properly qualified instructors to conduct the training. As a primary criteria, these individuals should possess both the subject matter knowledge and skills. It is also desirable that these individuals combine an interest in training with instructional capability and experience. Where deficiencies exist, a program should be implemented to enhance the instructor's knowledge, skills, or both. For those with limited background in training, it is wise to monitor their early instructional activities and provide feedback for improvement. This can be integral to the evaluation of program effectiveness described in 6.4.3. However, it is likely that additional attention may be appropriate in some cases.

6.3.2 *Select/Prepare Training Site*—The training site can strongly influence the quality of training. In many cases, such sites are clustered to form a "training facility" where required resources identified in 6.2.5 may be shared. The other extreme

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# Program Development/Content Documentation

**Employee Documentation** 

FIG. 6 Program Documentation

is use of the actual work site such as for pre-startup or on-the-job training. The classroom environment should include the following as they apply to the anticipated training:

6.3.2.1 *Acoustical Characteristics*—Can trainees hear; is special sound insulation required for noisy activities?

6.3.2.2 *Aids for Training*—Chalkboards and audiovisual equipment, etc.,

6.3.2.3 Adequate Lighting, and control of lighting,

6.3.2.4 Sufficient Space, for the class size and activities,

6.3.2.5 Arrangement of Space and Trainees, to permit good visibility,

6.3.2.6 *Ventilation*, for temperature and hazard control, and 6.3.2.7 *Freedom from Disruption*, of class activities.

6.3.2.8 The job and task analysis (6.1.2) should identify special equipment and site requirements. Unusual requirements should be factored into training site design early, particularly if time must be allowed for construction or modification.

6.3.3 *Identify and Select Employees*—The job analysis conducted in 6.1.2 provides the basis for determining the training required by various employees. The responsibility for ensuring that such training is accomplished should be clearly stated in company policy or procedure. Those responsible must identify to the appropriate scheduling function which employees require which training. The selection of employees to attend a specific course should involve consideration of appropriate factors such as the following:

6.3.3.1 Does the employee meet all prerequisite requirements?

6.3.3.2 Is this a need for present job assignment or a future change?

6.3.3.3 Is this a primary job responsibility or a backup?

6.3.3.4 How many employees can be removed from work assignments for training?

6.3.3.5 How soon is this training scheduled again?

6.3.4 *Conduct Program*—The training program should be given by capable instructors to designated employees at a suitable training site. Training should be conducted according to previously established lesson plans.

6.3.4.1 It is important to ensure that training is scheduled to be responsive to the needs as identified in 6.3.3, taking into account operating plans. Whenever possible, course schedules should be prepared and distributed well in advance to allow management to establish compatible personnel work schedules.

6.3.4.2 One important consideration should be to ensure training continuity. This occurs in two ways. First, training schedules should consider prerequisite requirements and offer related courses in the precedence sequence, with sufficient frequency, or both. Second, the instructional continuity of an individual class should be protected by trying to eliminate class disruptions and interruptions for nonessential business or personal reasons.

6.4 *Program Assessment*—This activity is an important part of any training effort and should examine the quality and success of the training program from several different viewpoints as shown in Fig. 5. A key activity is to determine if the expected results were achieved. Has the trainee attained the knowledge or skill? This also serves to document the trainee's capability and forms a basis for job qualification and certification. However, there should be more than an assessment of

outcomes or effects. A systematic inquiry into training contexts, needs, plans, and operation should help collect information to decide what is needed, what is working, and how to improve it. A final approach is a pragmatic look at the company's adherence to its own policies, plans, and procedures. Have specified activities occurred? This guide separates the efforts of evaluation and audit although many organizations may combine these into a single activity generally called an audit. The purpose here is to emphasize the difference between an examination based on operational or functional needs that may require interpretation (an evaluation) and a determination that a previously defined course of action was indeed taken (on audit). For example, the employee records might be *audited* to determine if all employees assigned to job X were properly "certified" (for example, completed training A, B, and C and evaluated as specified in administrative procedure 100.1.2). However, the training content should also be evaluated to determine that the learning activities (required for "certification") actually provide required knowledge and skill.

6.4.1 *Employee Evaluation*—Success in training occurs when the trainees meet the performance objectives for the course. This is determined by evaluating the individual against these objectives. This can occur in many ways:

- 6.4.1.1 Written Examinations,
- 6.4.1.2 Oral Examinations,
- 6.4.1.3 Performance Simulation, and
- 6.4.1.4 Performance Demonstration.

6.4.1.5 The comprehensiveness of a good evaluation is judged by the thoroughness with which the student performance objectives are represented in the evaluation process. The objectives should be found in the lesson objectives developed in 6.2.4. It is advisable to examine the lesson plans developed in 6.2.6 to determine if additional performance objectives are needed. This can be a valuable review of the process for developing the lessons by pointing out discrepancies in the lesson objectives.

6.4.1.6 It is highly important that the measurement criteria applied to the trainee be objective. This will improve the consistency of trainee evaluation by different evaluators and minimize the chance of bias. Good criteria would allow an independent individual to produce the same evaluation of a trainee's performance as that done by those designated to conduct evaluations.

6.4.1.7 Evaluating individuals should be designated on the basis of their knowledge of the specific subject being instructed. It is also highly desirable that these individuals also possess knowledge of subjects related to the specific instructional area. If certification is to occur, the criteria above should be even more carefully applied in determining certifying individuals. In addition, the certifying individuals should not report to the same operating organization as the trainees being certified.

6.4.2 *Evaluation for New Goals and Objectives*—The purpose of this activity is to make a thorough examination of the degree to which the training program provides required job knowledge and skills. An effective method is observation of employee performance while performing the actual job tasks. Another effective method is to obtain feedback about the

relevance of training through interviews/questionnaires with the employees and their immediate supervision, or both. A comparison can also be made between the goals and objectives developed in 6.1 and 6.2 and the actual job requirements. This can be done by an independent review (anyone other than the program developer) or it can be a planned review by the program developer.

6.4.2.1 It is important to recognize that this evaluation is not the same as revision of a program after a major change in the job. The primary value of this activity is to ensure that the program is on target or that quality is not lost due to a series of subtle changes in the employee's job.

6.4.3 *Evaluate Delivery Effectiveness*—The most effective evaluation of delivery is obtained by examining the results of the employee evaluation. This should be performed routinely to determine if, after training, there were consistent deficiencies in skill and knowledge of a significant number of trainees. As an example, 80 % of the class missed written examination questions 9 and 23.

6.4.3.1 It is also advisable to evaluate the trainees' reaction to the training program. The trainees may be asked to rate the instructor, the training environment, the presentation, their preparation for the training, the job applicability or other factors you may choose. This is often seen as merely determining if the employees like the training. However, if they find fault with some aspects, there may be need for improvement. Although there is no proof, it seems reasonable a more positive approach by the trainees should have a beneficial effect on their learning and retention.

6.4.4 *Evaluate Resources*—To ensure continued effectiveness of the training program, a periodic evaluation of the necessary resources should be made. This involves careful examination of the quantity and quality of the human and material resources identified in 6.2.5 for conducting the program. It also is very important to examine the resources which provide support to the program. These may be thought of as administrative or "overhead" resources and are usually personnel. Examples would be scheduling and recordkeeping functions and may include the program assessment resources. Immediate action should be taken to correct or avert major deficiencies in resources.

6.4.5 *Develop Audit Plan and Checklist*—The audit of the training program is a determination of conformance to previously defined criteria for the development and conduct of the program. Ideally, measurement should be a yes/no evaluation of compliance. The quality of the audit can be enhanced by careful planning. A detailed audit plan should be developed that identifies:

- 6.4.5.1 The characteristic to be examined,
- 6.4.5.2 The criteria for conformance and its source,
- 6.4.5.3 The means of testing conformance, and
- 6.4.5.4 Checklists that support the evaluation.

6.4.6 *Conduct Program Audit*—To ensure that the audit will go smoothly, any affected organizations should be informed well in advance. It may be useful to have their aid in developing the plan and checklists or to allow comments before the audit begins. The audit should strictly adhere to the plan. The results of the audit should then be reportable as findings or statements of indisputable fact. If, in the course of the audit, information is discovered that was not anticipated in the plan, this should be reported as observations.

6.4.6.1 Inherent in the conduct of the audit is the follow-up to ensure correction of deficiencies. Corrective action plans should be negotiated between the auditing function and the affected operation. This should ensure that appropriate action is taken without jeopardizing other training program activities.

6.5 *Program Documentation*—This activity provides for documentation of the training program. There are two general categories as indicated in Fig. 6. The documentation of program development and content should be traceable to the specific course. The documentation of employee training and qualification should be tracked for each employee. It is essential to maintain employee documentation to ensure that required training is completed and the proper qualification status is maintained for the assigned work. Careful attention to documentation is important for communication of program development, delivery, assessment, and, if necessary, revision.

6.5.1 *Program Definition*—Several phases within the activity should be documented by the training organization. These are:

6.5.1.1 *Defined goals* of the training program, as established in 6.1.1,

6.5.1.2 *Job tasks* performed by the trainees, as determined in 6.1.2,

6.5.1.3 *Program objectives* which should include the items addressed in 6.1.3, and

6.5.1.4 *Course sequence* that is an outline of the training program as formulated in 6.1.5.

6.5.2 *Program Development*—Included within this category as documentable phases should be:

6.5.2.1 Course objectives as defined in 6.2.1,

6.5.2.2 Probable lesson sequence identified in 6.2.3,

6.5.2.3 *Lesson plans* with the appropriate level of detail as formulated in 6.2.6,

6.5.2.4 *Employee qualifications* that encompass the knowledge and skill qualifications in each job category for which training is being provided. These are based upon the job description of each category in a specific plant. This job description may not be exhaustive but should indicate general kinds of tasks to be performed. In addition to knowledge and skill items, there should be documented minimum education and experience requirements for each category. 6.5.3 *Program Delivery*—If the training activity involves trainee evaluation, documentation of the evaluation methods should be maintained as a part of the course documentation as follows:

6.5.3.1 Questions and answer keys for written examinations,

6.5.3.2 Checklists and evaluation criteria for performance observation,

6.5.3.3 Questions and answers for oral examinations, and

6.5.3.4 Pass/fail criteria for the evaluation method.

6.5.3.5 It may also be useful to keep records of the dates, times, and attendance for the courses conducted.

6.5.4 *Program Assessment*—Assessment activities should be carefully documented. The documentation of trainee evaluation should include the following:

6.5.4.1 Name of trainee,

6.5.4.2 Name of evaluator,

6.5.4.3 Date of examination,

6.5.4.4 Pass/fail criteria,

6.5.4.5 Pass/fail status of trainee, and

6.5.4.6 Copy of written examination answer sheets.

6.5.5 When applicable, certification documentation should be maintained for each trainee to show the following:

6.5.5.1 Name of certified individual,

6.5.5.2 Level of certification,

6.5.5.3 Dates of effective period of certification,

6.5.5.4 Signature of certifying individual,

6.5.5.5 Training records to support certification, and

6.5.5.6 Name of certifying agency or organization.

6.5.6 The results of evaluations of program goals/ objectives, delivery effectiveness, and resources should be documented. These should include any recommendations for improvement, plans for corrective action that may be developed, and the progress or completion of action items.

6.5.7 Audit activities should be documented, including:

6.5.7.1 The audit plan,

6.5.7.2 Audit results including recommendations,

6.5.7.3 Corrective action plans,

6.5.7.4 Progress/completion of action items, and

6.5.7.5 Correspondence relating to the audit.

#### 7. Keywords

7.1 employee qualifications; instructors; job analysis; task analysis; training program

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