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TRAINING AND QUALIFICATION PROGRAM FOR NUCLEAR CRITICALITY SAFETY TECHNICAL STAFF

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ABSTRACT

A training and qualification program for nuclear criticality safety technical staff personnel has been developed and implemented. All personnel who are to perform nuclear criticality safety technical work are required to participate in the program. The program includes both general nuclear criticality safety and plant specific knowledge components. Advantage can be taken of previous experience for that knowledge which is portable such as performance of computer calculations. Candidates step through a structured process which exposes them to basic background information, general plant information, and plant specific information which they need to safely and competently perform their jobs. Extensive documentation is generated to demonstrate that candidates have met the standards established for qualification.

INTRODUCTION

A training and qualification program for nuclear criticality safety technical staff personnel has been developed and implemented. The program was developed to provide the necessary assurance that new personnel possessed the knowledge, skills and abilities required to perform their assigned duties during a period of rapid expansion of the nuclear criticality safety staff. It is compliant with the requirements of reference 1 and provides evidence that a systematic approach has been taken to indoctrinate technical staff new to the plant. Despite the structured nature of the program, significant flexibility is provided to allow the training and qualification to be tailored to individual needs.

The program was developed using a performance- based systematic approach to training, starting with a task analysis which examined the activities performed by the nuclear criticality safety staff to determine activities where training was necessary and to establish the standards which must be attained to qualify. Training is accomplished primarily through structured mentoring, where experienced personnel interact with candidates using checksheets to guide candidates through various steps and to provide evidence that steps have been accomplished. Credit can be taken for the previous experience of personnel by means of evaluation boards which can credit or modify checksheet steps.

Considering the volume of technical, administrative, and site specific information a person new to the plant needs to assimilate, the program has been effective in indoctrinating new technical staff personnel and integrating them into a productive role.

TASKS

The task analysis performed to define the program consisted of a series of "table top" sessions among senior nuclear criticality safety staff and training specialists and involved the entire technical staff through surveys and informal discussions. The goal was to identify activities that the nuclear criticality safety staff could expect to perform and to group the activities into tasks for training and qualification purposes. The analysis identified 13 tasks which are listed and briefly described in table 1. In addition to the tasks themselves, the analysis codified entry level requirements, general employee training requirements, duty area access requirements, and continuing training requirements which needed to be met and maintained through the training and qualification program.

STRUCTURE

Having identified tasks, design of the program followed. The training and qualification program was structured by grouping the tasks in a logical progression from new hire through senior experienced personnel. The basic structure was established which provided for qualification in individual tasks followed by qualification in overall collections of tasks. This arrangement was selected to allow rapid assimilation into productive activities through task qualification and to provide a continuing incentive for technical growth.

The initial qualification step that all new nuclear criticality safety technical personnel must satisfy is titled "Engineer-in-Training". It involves exposure to fundamental nuclear criticality safety concepts, readings from applicable procedures and technical documents, demonstration that job entry requirements such as a baccalaureate in engineering or related science are met, and compliance required training such as General Employee Training and security briefings. Fundamental nuclear criticality safety concepts are taught through mentored self-study of a number of business and basic nuclear criticality safety practice documents. This basic theory and practice training involves selected readings from Knief's book[2] followed by practical exercises derived from references 3 and 4 which introduce the new candidate to the specialized information sources available. The basic document readings include selections from basic nuclear criticality safety practice documents and from company and plant specific procedures. Following completion of the items noted, a candidate is considered to be an Engineer-in-Training and will embark on one of two qualification programs. Most candidates pursue the program which leads to qualification as Nuclear Criticality Safety Engineer and then to qualification as Nuclear Criticality Safety Specialist. The alternative path leads to qualification as Technical Specialist.

Qualification in the Nuclear Criticality Safety Engineer program requires qualification in the first four tasks of table 1, experience, and completion of an oral board. Qualification in the Nuclear Criticality Safety Specialist program follows qualification as Nuclear Criticality Safety Engineer and includes qualification in tasks 5 and 6 of table 1 (both of which require an oral board) plus any two of tasks 7 through 9, additional experience, and an oral board. The Technical Specialist Program is for those highly specialized personnel whose expertise is activities such as computations or emergency response. Qualification as Technical Specialist requires qualification in any three of the tasks 1 through 9, experience, and completion of an oral board.

The Nuclear Criticality Safety Engineer and Specialist programs include familiarization tours in physical plant areas where a candidate is expected to provide service. Once a candidate is qualified in a task and in particular physical plant areas, then that person is permitted to independently perform that task in those areas.

If a new candidate has previous experience, then an Experienced Personnel Evaluation board is formed comprised of qualified personnel specified by program documents[5, 6, 7] to examine evidence of the experience and decide whether or not all or part of some task requirements can be satisfied. Evidence can include certificates from short courses, relevant publications, and documentary samples of similar work performed at other facilities by the candidate.

Oral boards for tasks and for programs are comprised of qualified personnel specified by program documents to question and assess the responses of the candidate. Responses are scored separately by the examiners and are averaged for the final report. A unanimous decision on the pass/fail status of the candidate is required for qualification, and any weaknesses which should be discussed with the candidate are identified for follow-up training. Oral boards are required for tasks 5 and 6 of table 1 and for qualification in the Nuclear Criticality Safety Engineer and Specialist programs.

IMPLEMENTATION

One of the basic problems faced during the implementation of the training and qualification program was deciding and justifying who is initially qualified. This initial qualification was accomplished by convening a board of the three most senior members of the nuclear criticality safety function. The collective experience of the board was nearly 75 years in nuclear criticality safety and over 50 years within the plant. The board deliberated, task by task and person by person, the experience of the technical staff based upon the board's knowledge of the kinds of work which had been performed by incumbent technical staff prior to September, 1994. When the board unanimously agreed that a particular staff member was qualified in a task, then that staff member was recorded as so qualified. When the qualification of a board member was being deliberated, that member was not permitted to participate or vote in the consideration. After the qualification of technical staff incumbents was decided by board action, documentation required by procedures was executed to except them from training for qualification. Subsequent to the board evaluation of incumbents, all task and program qualification of technical staff, on loan personnel, and subcontractor personnel required that a person meet the standards and requirements for qualification by completing the required training or providing evidence which satisfied the standards and requirements by virtue of prior experience.

The training and qualification program is defined by program documentation and implemented using mentors and a variety of forms shown in the program documentation.[5, 6, 7] Mentors are qualified members of the technical staff who have completed a few required readings related to mentoring. Mentors help candidates by being available to discuss candidate's questions which arise as they do required readings and observe and perform activities specified on checklists and checksheets. The steps to be performed are shown on checklists for each program and on checksheets which expand upon checklist items. Some steps are prerequisites to others, but it is not in general necessary that each checklist and checksheet be completed in strict sequence. It is, indeed, advantageous to be constantly conscious of the training and qualification program and take advantage of any opportunity which presents itself to complete a checklist/checksheet

requirement. Samples of the checklist for the Engineer-in-Training program and of the checksheet for Basic Document Knowledge are shown in figures 1 and 2, respectively.

In addition to initial qualification, the program addresses periodic requalification and continuing technical training. Requalification is based upon participation in the continuing technical training aspects of the program and a satisfactory performance evaluation. Continuing technical training is an ongoing process which includes participation in industry conferences and a series of general training sessions which address issues relevant to nuclear criticality safety.

PROGRAM EVALUATION

The training and qualification program is expected to be subject to continuous improvement and periodic performance evaluations of the program are required to assist in the identification of weaknesses. The program is assessed from three perspectives: (1) programmatic compliance: does the program satisfy the requirements of relevant regulations; (2) performance compliance: is the program performed in accordance with the governing procedures; and (3) effectiveness: has the program achieved its intended result. All three areas are addressed during self-assessments, but the most crucial is the effectiveness perspective, and that has been the major focus of periodic program evaluations.

Program effectiveness has been, and continues to be assessed by evaluating both the product (qualified personnel) and the process. Various mechanisms have been employed including formalized assessment checklists, customer satisfaction surveys, comments from the technical staff, brainstorming sessions, and personnel performance evaluations. The performance evaluations have, in general, indicated that the training and qualification program has resulted in delivery and retention of the requisite knowledge, skills, and abilities. Modifications to the program have been made as a result of the evaluations, primarily to streamline the process.

EXPERIENCE

The training and qualification program was implemented in 1995 and was accompanied by startup problems and agonies as would be expected for something new and different. Some of the modifications made as a result of experience with the program include:

1. better definition of some of the expectations for checksheet steps and development of explicit criteria for successful completion of steps;

2. moving the two review tasks 4 and 5 from their original position in the Nuclear Criticality Safety Engineer program to the Nuclear Criticality Safety Specialist program;

3. changes in the composition of oral boards for task and program qualification;

4. the addition of a "Computation Technologist" which allows computer code computations to be run by personnel who are trained in the code but do not necessarily meet the degree requirements of the main program; and

5. the observation that oral boards need to be closely controlled because it is easy for examiners to slip from an examination mode into a teaching mode.

Appropriate use has been made of Experienced Personnel Evaluation boards to speed qualification of newly hired personnel with relevant, demonstrable experience. The protocol which has evolved is to step through checklist and checksheet items and accumulate evidence that the experienced person being examined has successfully performed similar work. In general, it has been found that no exceptions can be made for familiarization tours of physical plant areas or for required readings of various documents, primarily because plant areas and many of the documents are site specific and the information to be conveyed is simply unavailable elsewhere. Conversely, computation skills tend to be very portable and experience with external monitoring and nuclear criticality safety evaluations tends to be moderately so.

The human responses are interesting and, in retrospect, somewhat predictable. Entrants with little (<2 years)or no experience in nuclear criticality safety tend to embrace the program and find it to be the most and most focused training they have experienced. Although not universally the case, practitioners with extensive experience seem to view it more as a chore and may be somewhat offended by the idea that they need to qualify.

CONCLUSIONS

A program to train and qualify nuclear criticality safety technical staff has been developed and implemented. It has been demonstrated to be compliant with requirements[1] and effective in producing personnel qualified to conduct business. It has features such as Experienced Personnel Evaluation and task qualification which permit new technical staff personnel to quickly become productive in limited task and plant areas.

REFERENCES

1. DOE Order 5480.20A, "Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities," U. S. Department of Energy, Washington, D.C. (11/15/94).

2. R. A. Knief, *Nuclear Criticality Safety Theory and Practice*, American Nuclear Society, La Grange Park, Illinois (1985).

3. H. C. Paxton, J. T. Thomas, A. D. Callihan, and E. B. Johnson, "Critical Dimensions of Systems Containing U^{235}, Pu^{239}, and U^{233}," TID-7028, Los Alamos National Laboratory and Oak Ridge National Laboratory (June 1964).

4. H. C. Paxton and N. L. Pruvost, "Critical Dimensions of Systems Containing ^{235}U, ^{239}Pu, and ^{233}U - 1986 Revision," LA-10860-MS, Los Alamos National Laboratory, Los Alamos, New Mexico (July 1987).

5. K. J. Carroll, *et al*, "Nuclear Criticality Safety Department Qualification Program," Y/DD-694, Rev. 3, Oak Ridge Y-12 Plant, Oak Ridge, Tennessee (9/6/96).

6. K. J. Carroll, *et al*, "Nuclear Criticality Safety Department Training Implementation," Y/DD-696, Rev. 3, Oak Ridge Y-12 Plant, Oak Ridge, Tennessee (9/6/96).

7. K. J. Carroll, *et al*, "Nuclear Criticality safety Department Guidance for the Development of Continuing Technical Training," Y/DD-710, Oak Ridge Y-12 Plant, Oak Ridge, Tennessee (3/27/96).

Table 1 - Nuclear Criticality Safety Tasks

1. External Monitoring	Perform a comparison of operating area conditions and activities with nuclear criticality safety limits, conditions, and requirements in accordance with approved procedures
2. Nuclear Criticality Safety Evaluation	Perform nuclear criticality safety evaluation to demonstrate satisfaction of the double contingency principle in accordance with approved procedures
3. Operating Procedure Approval	Ensure that nuclear criticality safety limits, conditions, and requirements are correctly stated in operating procedures in accordance with approved procedures
4. Nuclear Criticality Safety Computations	Perform nuclear criticality safety computer calculations in accordance with approved procedures
5. Nuclear Criticality Safety Computation Review	Perform independent assessments of the adequacy of nuclear criticality safety computations produced by others in accordance with approved procedures
6. Nuclear Criticality Safety Evaluation Review	Perform independent assessments of the adequacy of nuclear criticality safety evaluations produced by others in accordance with approved procedures
7. Emergency Response Planning	Advise emergency preparedness function in matters concerning nuclear criticality accident emergency preparedness planning in accordance with approved procedures
8. Criticality Accident Alarm System (CAAS) Support	Perform as subject matter expert in setting standards for CAAS siting and testing and serve on CAAS Configuration Control Board
9. Order Compliance and Nuclear Criticality Safety Procedures	Evaluate DOE Orders and guidelines, national standards, and corporate and plant procedures for nuclear criticality safety programmatic impact
10. Independent Technical Review Board (ITRB)	Independent review of nuclear criticality safety evaluations and computations
11. Final Nuclear Criticality Safety Technical Documentation Approval	Provide final approval of nuclear criticality safety technical documentation
12. Nuclear Criticality Safety Program Oversight	Recommend modifications of nuclear criticality safety program and procedures
13. Emergency Operations Center (EOC) Support	Advise plant management of nuclear criticality safety considerations during real or simulated emergencies in accordance with approved procedures

Figure 1 - Engineer-in-Training Checklist

NCS ENGINEER IN TRAINING MENTORING CHECKLIST TMS # 14666

Candidate:_____/_____ Group Leader:_____/_____
Name Badge Name Badge

Date Complete: Activity:

____/____/____ Educational Requirements
Evidence of Baccalaureate in engineering or related science (diploma, transcript, or equivalent) on file in the NCSD training records.

Verified by:_____
Training Coordinator

____/____/____ Job Fundamentals
Evidence of job fundamentals LMES training on file in the LMES training records.

Verified by:_____
Training Coordinator

____/____/____ Basic theory and practice knowledge
Read and demonstrate satisfactory knowledge of Nuclear Criticality Safety by R. A. Knief by completion of Basic Theory and Practice checksheets parts 1 - 3.

Verified by:_____
Training Coordinator

____/____/____ Basic document knowledge
Read and demonstrate satisfactory knowledge of selected codes, standards and site documents by completion of Basic Document Knowledge checksheet.

Verified by:_____
Training Coordinator

Candidate:_____/_____ is recommended for qualification as NCS Engineer in Training.

Group Leader:_____/_____ Date:_____

This form is approved for use R. L. Taylor
QVO

Figure 2A - Basic Document Knowledge Checksheet (page 1 of 3)

Nuclear Criticality Safety Engineer Mentoring Checksheet

for

Basic Document Knowledge

Candidate/badge: _____ Supervisor/badge: _____

Basic Instructions and Sign-off Criteria:

All Items: Sign-off indicates that the Candidate has raised any questions or issues resulting from the reading with the mentor and that the mentor has provided an answer to address the questions/issues raised. No specific documentation of the discussion is necessary, however, if the discussions indicate the need for a procedure revision, this should be noted in the appropriate document history file maintained by the Compliance Group. Except for item 3 (Group Leader sign-off), any NCS Engineer , NCS Specialist, or Technical Specialist who has received mentor orientation may discuss and sign-off.

1. Read the following NCS-related documents and discuss with mentor.

DOCUMENT	TITLE	REVISION	SECTION	COMPLETION
NUREG/CR-0095, ORNL/NUREG/CSD-6	Nuclear Safety Guide, TID-7016	Revision 2	Pages 1 - 11	Date: _____ Mentor: _____
NUREG/CR-0095, ORNL/NUREG/CSD-6 and DOE/NCT-04	Nuclear Safety Guide, TID-7016 A Review of Criticality Accidents	Revision 2	Pages 13 - 21 Pages 3 - 18	Date: _____ Mentor: _____
DOE Order 5480.19	Conduct of Operations		All	Date: _____ Mentor: _____
DOE Order 5480.24 and Interpretive Guidance for DOE Order 5480.24	Nuclear Criticality Safety		All	Date: _____ Mentor: _____
ANSI/ANS-8.1-1983 (Reaffirmed 11/30/88)	Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors		All	Date: _____ Mentor: _____
ANSI/ANS-8.3-1986, the Clarification of Paragraphs (1) 4.2, (2) 4.2.2, 4.4.3, 4.4.4, 4.5.3, 5.3, 5.7.1, and (3) 5.5, 4.2.2; and the Interpretation of Paragraph 5.2	Criticality Accident Alarm System		All	Date: _____ Mentor: _____
ANSI/ANS-8.19-1984 (Reaffirmed 8/29/89)	Administrative Practices for Nuclear Criticality Safety		All	Date: _____ Mentor: _____

Figure 2B - Basic Document Knowledge Checksheet (page 2 of 3)

DOCUMENT	TITLE	REVISION	SECTION	COMPLETION
ESS-CS-101	Nuclear Criticality Safety Program Elements	Rev: _____	All	Date: _____ Mentor: _____
ESS-CS-102	Nuclear Criticality Safety Approval	Rev: _____	All	Date: _____ Mentor: _____
ESS-CS-103	Nuclear Criticality Safety Calculations	Rev: _____	All	Date: _____ Mentor: _____
ESS-CS-104	Criticality Accident Alarm System (CAAS)	Rev: _____	All	Date: _____ Mentor: _____
Y10-189	Document Control	Rev: _____	All	Date: _____ Mentor: _____
Y70-150	Nuclear Criticality Safety	Rev: _____	All	Date: _____ Mentor: _____
Y70-151 PES/164/012291	Criticality Accident Alarm System. Alarm System Layout (Drawing)	Rev: _____ Rev: _____	All	Date: _____ Mentor: _____
Y70-159	Fissile Material Activity Identification, Marking, and Requirements Posting	Rev: _____	All	Date: _____ Mentor: _____
Y70-160	Criticality Safety Approval System	Rev: _____	All	Date: _____ Mentor: _____
Y50-66-CS-325	Nuclear Criticality Safety Analysis, Approval, and Control System	Rev: _____	All	Date: _____ Mentor: _____
Y50-66-CS-328	QA for Nuclear Criticality Safety Computer Calculations	Rev: _____	All	Date: _____ Mentor: _____
Y70-66-CS-327	Nuclear Criticality Safety Incidents and Deficiencies	Rev: _____	All	Date: _____ Mentor: _____
Y70-66-CS-330	Nuclear Criticality Safety External Monitoring	Rev: _____	All	Date: _____ Mentor: _____
Y70-66-CS-332	Criticality Safety Requirements Development, Review and Approval	Rev: _____	All	Date: _____ Mentor: _____
Y/DD-430	NCSD Quality Assurance Plan	Rev: _____	All	Date: _____ Mentor: _____
Y/DD-552	NCSD Self-Assessment Plan	Rev: _____	All	Date: _____ Mentor: _____
Y/DD-675	Charter for the NCS ITRB	Rev: _____	All	Date: _____ Mentor: _____
Y/DD-704	NCSD Administrative Guide	Rev: _____	All	Date: _____ Mentor: _____
Y/DD-708	NCS Guidelines for Fire Fighting	Rev: _____	All	Date: _____ Mentor: _____
Y/DD-716	Guidance for Performing Reviews of Procedures Controlling FMAs	Rev: _____	All	Date: _____ Mentor: _____
Y/DD-717	Annual Reviews of Non-continuing Operations FMAs	Rev: _____	All	Date: _____ Mentor: _____

Figure 2C - Basic Document Knowledge Checksheet (page 3 of 3)

DOCUMENT	TITLE	REVISION	SECTION	COMPLETION
Y/DD-724 (when issued)	NCS Guidance for STAs	Rev: _____	All	Date: _____ Mentor: _____

2. There is a Standing Order system implemented in the Nuclear Criticality Safety Department (NCSD). Read all the currently effective Standing Orders.

date completed: _____ mentor: _____

3. There is a Required Reading system implemented in the NCSD. Read any existing Required Readings specified by your Group Leader.

date completed: _____ Group Leader: _____

This form is approved for use R. L. Taylor
QVO

Distribution:

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