THE TRAINING OF UTILITY ENGINEERS FOR
NUCLEAR PLANT SEISMIC EVALUATION FOR
USI A-46 AND SEISMIC IPEEE

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ABSTRACT

In response to Nuclear Regulatory Commission (NRC) Unresolved Safety Issue (USI) A-46, "Seismic Qualification of Equipment in Operating Nuclear Plants," the Seismic Qualification Utility Group (SQUG), with the support of the Electric Power Research Institute (EPRI), has developed procedures, criteria, and data to apply actual experience on the performance of equipment during earthquakes and shake table tests to the verification of seismic adequacy of similar equipment in nuclear power plants. The procedure developed by SQUG requires that the individuals who will utilize the SQUG earthquake and shake table test experience data complete a SQUG-approved training program on seismic evaluation of nuclear power plant equipment. Therefore, SQUG developed a training program to meet this requirement.

In addition, through collaboration between SQUG, EPRI and NUMARC, an add-on course was developed and implemented to address the seismic portion of GL 88-20, Supplement 4, "Individual Plant Examination, External Events (IPEEE)." The NRC does not require, but does highly recommend integration and coordination of the similar A-46 and seismic IPEEE programs at A-46 plants; thus the training programs were integrated.

The purpose of this paper is to describe the development, implementation, and current status of the training program developed as part of the response to USI A-46 and GL 88-20.

INTRODUCTION

The requirements for seismic design of nuclear power plants have changed significantly from the early 1960s to the present. Due to the extent of the changes in seismic design requirements and a concern about the seismic adequacy of equipment in older operating nuclear plants, the Nuclear Regulatory Commission (NRC) issued Unresolved Safety Issue USI A-46, "Seismic Qualification of Equipment in Operating Nuclear Plants," in December 1980. The purpose of USI A-46 is to verify the seismic adequacy of essential equipment in operating plants which have not been qualified in accordance with the more recent criteria.

In response to USI A-46, a group of affected electric utilities formed the Seismic Qualification Utility Group (SQUG) in 1982 to develop a practical method of verifying seismic adequacy of installed equipment and its anchorage. SQUG, with the support of the Electric Power Research Institute (EPRI), has developed procedures, criteria, and data to apply actual experience on the performance of equipment during earthquakes and shake table tests to the verification of seismic adequacy of similar equipment in nuclear power plants. The "Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment" is the primary procedure developed by SQUG to provide technical guidance on the use of experience data for the verification of equipment in individual plants. The GIP includes provisions for selecting the equipment to be evaluated; performing a seismic evaluation of selected mechanical and electrical equipment, tanks and heat exchangers, and cable trays; evaluating equipment anchorage; and performing an evaluation of electrical relays. The NRC has approved this methodology both as a means to respond to USI A-46 and as a means to
verify the seismic adequacy of replacement and modifications to the selected equipment in the future. The GIP requires that the individuals who will perform the procedure successfully complete a SQUG-approved training program on seismic evaluation of nuclear power plant equipment. Due to this requirement, SQUG has developed a training program on the SQUG methodology as set forth in the GIP.

Because of the extensive similarities between the SQUG A-46 program and the seismic portion of IPEEB, and the desire of A-46 utilities to integrate and coordinate these two programs, SQUG, in cooperation with EPRI and NUMARC developed 'add-on' training to the SQUG developed courses. This training addresses the similarities and differences in the equipment selection, relay evaluation, and walkthrough screening and seismic evaluation of equipment. While SQUG training is the focus of this paper, the add-on courses will be discussed in the PROGRAM STATUS section, below.

TRAINING PROGRAM DEVELOPMENT

A systematic design process similar to that used by nuclear utilities in the development of Institute of Nuclear Power Operations (INPO) accredited training programs was adapted for use in the development of the SQUG program. The steps in the process of developing such a training program are:

- An analysis of training requirements, commonly referred to as a "needs analysis;"
- The primary design of the program content, including a task analysis, the development of training objectives, and development of an outline;
- The selection of the program delivery method;
- The development of actual training materials and testing materials;
- Adaptation of the training materials to the selected delivery method; and
- Implementation of the training.

Each of these steps is discussed below.

Needs Analysis

The needs analysis for the SQUG training program included two tasks: an analysis of the training audience; and an analysis of programmatic issues such as training program admission requirements, testing requirements, and trainee certification.

Target Audience. The target training audience was analyzed for both short-term training for resolution of USI A-46 and long-term training for later use of the SQUG methodology for replacements and modifications. This was accomplished by polling the SQUG members by questionnaire. The SQUG utility response rate was 90%.

Training engineers to resolve USI A-46 will involve an audience of at least 500 utility engineers located through the United States. The majority of the SQUG member utilities intend to use their own personnel to resolve USI A-46; however, many members plan to supplement their personnel with consultants or architect-engineers. The audience size of 500 includes these nonutility personnel who will also require training.

SQUG members reported that the utility engineers who will attend the training have an average of 12 years of general engineering experience with an average of almost seven years of seismic engineering experience. All engineers are degreed. Over two-thirds of the trainees have bachelor's degrees, with one-quarter also having masters degrees and the remainder having doctorates. More than half of the trainees have civil engineering degrees, while almost one-third have mechanical engineering degrees, and the remainder have electrical engineering degrees or degrees in various other related disciplines.

The SQUG member utilities overwhelmingly intend to use the SQUG methodology in the long-term for replacements and modifications and would like training on the SQUG methodology to be available on a long-term basis.

Programmatic Issues. The SQUG training programmatic issues covered in the needs analysis include Admission Requirements, Pre-Training Testing, Certification of Trainees, and In-Training and Post-Training Testing.

There are no qualification requirements for admission to the training for SQUG member designated trainees, allowing SQUG members to train any of their personnel, including management or less experienced engineers. Since there are qualification requirements for actually performing the seismic reviews as specified in the GIP, it is anticipated that some trainees will attend the training for information only.

Certification of attendance in the training will be issued. Certification of attendance does not serve as certification of qualification to perform seismic reviews. It is the responsibility of the individual utilities to ensure that the personnel performing the seismic reviews are qualified.

Tests or quizzes will be given before, throughout and at the completion of the training since student attention and retention have been shown to increase when testing accompanies a training course. Tests or quizzes will be included for the purpose of improving student attention and retention, for providing feedback to the training program developers on the effectiveness of the training, and for providing feedback to the student on areas requiring additional study.

Program Content

To begin the preliminary design of the program content, a task analysis was prepared which lists all
tasks that must be performed to complete the GIP. The task analysis, and consequently the entire training program, were divided into two areas: (1) Seismic Walkdown and (2) Equipment Selection and Relay Evaluation.

Training objectives for the courses were then defined. Training objectives are statements of what the trainee should be able to do at the completion of the course. To define these objectives, each task in the task analysis was evaluated to determine the skills and knowledge required to perform the task. The skills and knowledge required were compared to the knowledge levels of the incoming trainees, as stated in the definition of the target audience. The material, which must be taught in the course is the difference between the required knowledge and the knowledge of the incoming trainee, expressed as training objectives.

Using the training objectives, training course outlines for a Seismic Walkdown training course and for an Equipment Selection and Relay Evaluation training course were drafted. The major topics in these outlines are as follows:

**Seismic Walkdown Training**

I. Introduction
II. Tour of the GIP
III. Seismic Capacity vs. Seismic Demand
IV. Anchorage
V. Equipment Categories
VI. Seismic Interaction
VII. Case Studies (Electrical/Mechanical)
VIII. Implementation Topics
IX. Site Visit
X. Tanks and Heat Exchangers
XI. Cable Trays and Conduit Raceways
XII. Cable Tray Case Study

**Equipment Selection and Relay Evaluation Training**

I. Introduction
II. Identification of Safe Shutdown Equipment
III. Relay Screening and Evaluation
IV. Workshops

The course content was reviewed as it progressed by training personnel from SQUG member training departments.

**Delivery Method Selection**

The delivery methods under consideration for the SQUG training program were self-instructional media, including computer-based interactive videodisc (IVD) and videotape options; classroom instruction; and some combination of these.

**Walkdown Training.** In order to select a delivery method for the SQUG Walkdown training course, it was necessary to first examine the important criteria which govern the selection. These selection criteria are as follows:

- Needs of the Course as defined in the needs analysis. This includes such considerations as the following:
  - **Number of Trainees:** The SQUG members intend to train at least 300 utility engineers in the short-term for the resolution of USI A-46. This does not generally include any consultants hired by SQUG members to assist in the resolution of USI A-46 or any managers or others tangentially involved with the process who may desire training to some extent in the SQUG methodology.

- **Long-Term Use of the SQUG Methodology:** The SQUG members intend to use the SQUG methodology in the long-term for seismic qualification of replacements and modifications. With this long-term use of the SQUG procedure, a majority of the SQUG members expressed a desire for long-term availability of training. Long-term training availability is also necessary to accommodate normal turnover and reassignment of utility personnel.

- **Availability of Instructors:** It may be difficult to ensure the availability of the SQUG consultants as instructors over the several-year period that the needs analysis indicates training is required.

  - **Most Effective Means to Convey the Course Material as Defined in the Course Outline.**
  - **Cost to Develop and Deliver the Training Course.**
  - **Schedule for Development of the Training Course.**

Each of the delivery methods evaluated were considered adequate to provide the SQUG training. The selection of a single method, then, relied on the priority of the selection criteria.

In order to meet the needs of the course as listed above, it was clear that some method of prepackaging the training is necessary. That is, it was necessary to employ one of the self-instructional delivery methods. Considering the high, and possibly uncertain, development cost and schedule of interactive videodisc training, a video-based course with a workbook was selected. Delivery of the training using a classroom method would be performed for the immediate training needs and to review and revise the content and delivery of the course before committing it to a "permanent" medium.

**Equipment Selection and Relay Evaluation Training.** The same four selection criteria listed above for Walkdown training were used to select the delivery method for the Equipment Selection and
The test questions for the video course will contain more exercises and less interactive discussion questions.

**Adaptation and Implementation**

The final steps in the development of the SQUG training program are adaptation of the training to the selected delivery method and implementation of the program.

When the technical training materials and testing materials for the Walkdown training were completed, adaptation to the videotape and workbook media began. Once the course exists in these media, it will be implemented. The implementation process began with a live lecture "dry-run" training session during which the course was reviewed and revised as necessary. Ultimately, implementation will consist of training sessions without revision except when new earthquake or testing experience data become available and necessitate change to the course.

The technical training materials for the Equipment Selection and Relay Evaluation training are complete and have been adapted to the classroom medium. To date, the course has been implemented nine times, with revision resulting from the initial sessions.

**PROGRAM STATUS**

The status of the overall SQUG program, including the training effort, is discussed below.

**Generic Implementation Procedure**

The final GIP (Revision 2) is complete. This version includes all necessary technical criteria and guidelines, as well as agreed upon licensing provisions. The latter include, for example, the rules with which the GIP can be used for future plant equipment replacements and modifications.

**NRC Acceptance**

The NRC Safety Evaluation Report (SER) Supplement 1 was received by SQUG in 1990. In the SER, the NRC basically confirmed the SQUG understanding of licensing requirements. The NRC "final" SER accepting the GIP, Revision 2, was received in the Summer of 1992. Utilities have responded to the NRC with proposed completion schedules.

**Training**

In addition to the dry-run of the course, four sessions of the Walkdown training course have been given using the classroom method. Based on evaluation forms filled out by the trainees, which have included the NRC, NUMARC, SQUG management and training consultants, the course is extremely useful, well-organized and effective. The pre-test was found to be instrumental in preparing the trainees for the 5-day course. Also, the case studies and site visit
proved to be quite valuable in practicing the application of the methods taught. For adaptation to the video tape method, video case studies will be used, and each utility training department will be given guidance on how to conduct a site visit at their own facilities. The Walkdown course will be offered in classroom style through the summer of 1993. The video course is being developed in parallel and should be completed by the fall of 1993.

To date, nine sessions of the Equipment Selection and Relay Evaluation training course have been given, training over 200 personnel. The course continues to be well-received. While all utilities had sent at least one trainee by the end of 1991, attrition required two additional courses to be offered in 1992, and one in 1993.

Implementation

Many utilities have started development their lists of safe shutdown equipment and gathering available seismic-related data. Three plants, Zion, Nine Mile Point Unit 1, and Hatch, are well into the SQUG process as a result of pilot reviews (Zion and NMP-1 were SQUG sponsored). Other plants expect to implement the methodology between 1992 and 1995. Implementation dates will be plant-specific and dependent on plant outage schedules and workloads. Implementation may also depend upon the plant schedule for IPEEE work which will likely be coordinated with the SQUG effort.

Seismic IPEEE

A separate 3-day add-on course was developed to compliment the SQUG walkdown training course by addressing the similarities and differences in the walkdown screening and seismic evaluation. The course focuses on the Seismic Margins Methodology as described in EPRI NP-6041, Rev. 1, since this method most closely follows the deterministic approach of the GIP. The course does have a short section on Seismic Probabilistic Risk Assessment (SPRA), highlighting the common areas in the required walkdown portion of the program. The outline for the Seismic IPEEE Add-On Course is given below:

Seismic IPEEE Add-On Training

I. Introduction and Background
II. Similarities and Differences Between the GIP and NP-6041 Review Steps
III. Seismic Input
IV. Component Screening
V. SMA Philosophy and Conservatism
VI. Methods for Calculating HCLPFs
VII. Documentation Requirements
VIII. Seismic Probabilistic Risk Assessment
IX. Scaling Structure Responses and In-Structure Response Spectra
X. Specific Guidance for Calculating HCLPFs and Example Problems - Pt. 1
XI. Specific Guidance for Calculating HCLPFs and Example Problems - Pt. 2
XII. Procedures for Developing CDFM Factors

Because of the one-time "information request" nature of Generic Letter 88-20, and no long-term interest for new and replacement parts, there are no long term needs for training; therefore, the seismic IPEEE add-on course will only be given in classroom style. The add-on course was developed as a separate course, given in classroom style about a month after the prerequisite 5-day SQUG Walkdown course. The two main reasons for this approach are: to reduce the strain on the trainees being away for more than one week at a time, and to allow the trainees to prepare for the add-on course, including completion of a separate pre-test. The add-on course was developed and is given by SMEs who were principal developers of the SMA methodology and NP-6041. The add-on course has been given four times and has been well received. Classroom courses will continue to be given through 1993.

For equipment selection and relay evaluation, the seismic IPEEE training content was successfully incorporated into the existing SQUG training, without increasing the two-day/course time requirement. For the last three sessions given in 1992, the requirements for the applicable sections of Seismic IPEEE were presented. A-46 and the GIP were used as the foundation, with differences applicable to seismic IPEEE highlighted and explained where appropriate.

REFERENCES


Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment, Revision 2, Seismic Qualification Utility Group (SQUG), February, 1992.