Section 1
Introduction

1.1 PURPOSE

The purpose of this procedure is to summarize the technical approach and provide generic procedures and documentation requirements which can be used by owners/operators of operating nuclear power plants to verify the seismic adequacy of the mechanical and electrical equipment needed to bring the plants to a safe shutdown condition following a safe shutdown earthquake (SSE). This procedure can be used to address the NRC Unresolved Safety Issue (USI) A-46, "Seismic Qualification of Equipment in Operating Plants," as required by NRC Generic Letter 87-02 and supporting documents (References 1, 2, and 3). [1]Note that the references cited in Part II of the GIP are listed in Section 10 below.

The scope of equipment covered in this procedure includes active mechanical and electrical equipment such as: motor control centers; switchgear; transformers; distribution panels; pumps; valves; HVAC equipment; batteries and their racks; engine and motor generators; and instrumentation and control panels, cabinets, and racks. Relays are also reviewed in this procedure to determine if plant safe shutdown systems could be adversely affected by relay (contact) chatter as a result of a SSE. In addition, this generic procedure includes guidelines for evaluating the seismic adequacy of tanks, heat exchangers, and cable and conduit raceway systems.

1.2 BACKGROUND

The requirements for seismic design of nuclear power plants from 1960 to the present have evolved from the application of commercial building codes (which use a static load coefficient approach applied primarily to major building structures) to more sophisticated methods today. Current nuclear seismic design requirements for new plants consist of detailed specifications including dynamic analyses or testing of safety-related structures, equipment, instrumentation,

controls, and their associated distribution systems (piping, cable trays, conduit, and ducts). Because of the extent of changes in the design requirements which have occurred over the years, the NRC initiated USI A-46, "Seismic Qualification of Equipment in Operating Plants," in December of 1980, to address the concern that a number of older operating nuclear power plants contained equipment which may not have been qualified to meet the newer, more rigorous seismic design criteria. Much of the equipment in these operating plants had been installed when design requirements, seismic analyses, and documentation were less formal than the rigorous practices currently being used to build and license nuclear power plants. However, it was realized that it would not be practical or cost-effective to develop the documentation for seismic qualification or requalification of safety-related equipment using procedures applicable to plants currently under construction. Therefore, the objective of USI A-46 was to develop alternative methods and acceptance criteria which could be used to verify the seismic adequacy of essential mechanical and electrical equipment in operating nuclear power plants.

In early 1982, the Seismic Qualification Utility Group (SQUG) was formed for the purpose of collecting seismic experience data as a cost-effective means of verifying the seismic adequacy of equipment in operating plants. One source of experience data is the numerous non-nuclear power plants and industrial facilities which have experienced major earthquakes. These facilities contain industrial grade equipment similar to that used in nuclear power plants. Another source of seismic experience data is shake table tests which have been performed since the mid 1970's to qualify safety-related equipment for licensing of nuclear plants. To use these sources of seismic experience data, SQUG and the Electric Power Research Institute (EPRI) have collected and organized this information and have developed guidelines and criteria for its use. This procedure is the generic means for applying this experience data to verify the seismic adequacy of mechanical and electrical equipment which must be used in a nuclear power plant during and following a safe shutdown earthquake.

1.3 APPROACH

The approach used in this procedure for verifying the seismic adequacy of mechanical and electrical equipment is consistent with the intent of NRC Generic Letter 87-02, "Verification of

Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46" (Reference l), including NUREG-1030 (Reference 2) and NUREG-1211 (Reference 3). The approach is also consistent with the EPRI Seismic Margins Assessment Program (SMA) described in Reference 12. The four major steps used in this procedure for the majority of the equipment to be evaluated are listed, below, along with the section of the procedure where these steps are covered in detail:

- Selection of Seismic Evaluation Personnel (Section 2)
- Identification of Safe Shutdown Equipment (Section 3)
- Screening Verification and Walkdown (Section 4)
- Outlier Identification and Resolution (Section 5)

The seismic adequacy verification of the following types of equipment are covered in separate sections:

- Relay Functionality Review (Section 6)
- Tanks and Heat Exchangers Review (Section 7)
- Cable and Conduit Raceway Review (Section 8)

The documentation requirements for these reviews are included in each of these sections and in Section 9.

Each of the sections of Part II of the GIP (Sections 2 through 9) is divided into SQUG commitments and implementation guidance. The SQUG commitments, which follow the introduction in each of these sections, describe the key features of this procedure. The remainder of each section provides guidance for implementing the commitments.

The remainder of this section summarizes the material covered in Sections 2 through 9.

1.3.1 Seismic Evaluation Personnel

Several types of individuals, their qualifications, and their responsibilities for implementing this procedure are described in Section 2. These individuals include: (1) Systems Engineers who identify the methods and the equipment needed for bringing the plant to a safe shutdown condition, (2) Plant Operations Personnel who have a comprehensive understanding of the plant layout and the function and operation of the equipment and systems in the plant and who compare the plant operating procedures to the safe shutdown equipment list for compatibility, (3) Seismic Capability Engineers who perform the Screening Verification and Walkdown of the safe shutdown equipment, and (4) Relay Evaluation Personnel who perform the relay functionality review.

Since the instructions and requirements contained in this procedure are guidelines and not fixed, inflexible rules, the Seismic Capability Engineers must exercise sound engineering judgment during the Screening Verification and Walkdown. Therefore the selection and training of qualified Seismic Capability Engineers for participation on the Seismic Review Teams (SRTs) is an important element in this Generic Implementation Procedure for resolution of USI A-46.

Section 2 also describes the SQUG-developed training course which should be taken by the individuals who perform the seismic review of the plant. These courses provide assurance that there is a minimum level of understanding and consistency in applying the guidelines contained in this procedure.

1.3.2 Identification of Safe Shutdown Equipment

The mechanical and electrical equipment needed to achieve and maintain a safe shutdown condition in a nuclear plant are identified in a two-step approach in Section 3 and Appendix A. The first step is to define the various alternative methods or paths which could be used to accomplish each of the four following safe shutdown functions:

- Reactor Reactivity Control
- Reactor Coolant Pressure Control

- Reactor Coolant Inventory Control
- Decay Heat Removal

One of the alternate methods for accomplishing each of these functions should be selected as the preferred safe shutdown alternative. This selection should also include backup equipment or a backup train of equipment so that the plant can be shut down in the event there is an active failure or unavailability of a single item of equipment. Equipment in other alternative methods can also be identified, if desired.

The second step is to identify the individual items of safe shutdown equipment for the preferred method by tracing out the path of action, fluid, and/or power on system description drawings and by developing a safe shutdown equipment list (SSEL).

The SSEL should be shown to be compatible with the plant operating procedures by the plant's Operations Department.

The scope of equipment which should be reviewed for resolution of USI A-46 includes active mechanical and electrical equipment, tanks, heat exchangers, and cable and conduit raceway systems which are needed for safe shutdown. Excluded from the scope of review because of their demonstrated ruggedness (as summarized in Reference 17) are major pieces of equipment in the Nuclear Steam Supply System (NSSS) which are located inside containment (e.g., reactor vessel, steam generators, etc.). Section 3.3 discusses the scope of equipment to be reviewed in more detail.

Screening guidelines are provided in the GIP for evaluating the seismic adequacy of most types of equipment which are used in nuclear power plants for safe shutdown. However, as discussed below, if an item of equipment which is within the scope of USI A-46 is not covered by the screening guidelines, then it should be identified as an outlier and evaluated separately.

1.3.3 Screening Verification and Walkdown

The Screening Verification and Walkdown of mechanical and electrical equipment is described in Section 4. Appendices B through G provide supplemental information for performing this seismic adequacy verification. The seismic adequacy verification of relays, tanks and heat exchangers, and cable and conduit raceways are described in Sections 6, 7, and 8, respectively, and are summarized later in this Introduction.

The purpose of the Screening Verification and Walkdown is to screen out from further consideration those items of equipment which pass certain generic, seismic adequacy criteria. The screening verification is based heavily on the use of seismic experience data. Those items of equipment which do not pass the screening verification are considered "outliers" and should be evaluated further as described in Section 5.

The four areas considered during the Screening Verification and Walkdown of safe shutdown equipment are:

- Comparison of the equipment seismic capacity to the seismic demand imposed upon it.
- Determination that the seismic experience data is applicable to the plant-specific safe shutdown equipment.
- Evaluation of the equipment anchorage adequacy.
- Check for adverse seismic spatial interactions.

1.3.4 Outlier Identification and Resolution

Items of safe shutdown equipment that do not pass the screening criteria contained in the GIP are considered outliers (i.e., they lay outside the scope of coverage for the screening criteria) and should be evaluated further as described in Section 5.

Methods of outlier resolution are typically more time consuming and expensive than the screening evaluations provided in the GIP. Also, outlier resolution may be somewhat open-ended in

that several different options or approaches are available to verify the seismic adequacy of the equipment. The most appropriate method of outlier resolution will depend upon a number of factors such as (1) which of the screening criteria could not be met and by how much, (2) whether the discrepancy lends itself to an analytical evaluation, (3) how extensive the problem is in the plant and in other plants, and (4) how difficult and expensive it would be to modify, test, or replace the subject items of equipment.

1.3.5 Relay Functionality Review

The purpose of the relay functionality review, which is summarized in Section 6, is to verify that plant safe shutdown systems cannot be prevented from performing their safe shutdown functions by relay (contact) chatter as a result of an earthquake.

The first step in the review is to screen out from further consideration all those systems for which relay chatter would not significantly affect the safe shutdown systems or for which operator actions could be taken to reset the system following the earthquake. The second step is to evaluate the seismic adequacy of the individual relays which have not been screened out by comparing the seismic demand imposed on the relays with their seismic capacity. These essential relays are also walked down as part of this evaluation to spot check relay types, mountings, and locations, and, if necessary, to estimate in-cabinet amplification factors.

1.3.6 Tanks and Heat Exchangers Review

The review of tanks and heat exchangers for seismic adequacy is described in Section 7 and includes evaluations for: (1) stability of tank walls to prevent buckling (for large, vertical ground- or floor-mounted tanks only), (2) anchorage and load path strength, (3) support member strength (e.g., support saddles and legs), and (4) adequate flexibility of attached piping to accommodate the motion of large, flat-bottom, vertical storage tanks. Screening guidelines are provided in the form of charts and calculation formulas that simplify the complex dynamic fluid-structure interaction analyses for large vertical tanks and simplify the equivalent static analysis method for horizontal tanks.

1.3.7 Cable and Conduit Raceway Review

Guidelines for verifying the seismic adequacy of electrical cable and conduit raceway systems are included in Section 8. Seismic adequacy of raceway systems is defined as protecting electrical cable function and maintaining overhead support. The screening guidelines address seismic adequacy by (1) using walkdown guidelines and (2) performing limited analytical reviews.

The walkdown guidelines have two purposes. First, the raceway systems are screened to check that they are representative of the raceway systems which have performed well during seismic events and do not include certain details that may lead to undesirable seismic performance. Second, worst-case bounding samples of as-installed raceway system supports are selected for limited analytical review.

A limited analytical review is performed to check that the bounding sample supports are as rugged as those that have been shown to perform well during past earthquakes. These checks address the raceway support dead load integrity, ductility, vertical capacity, and lateral capacity.

1.3.8 Documentation

The types of documents which should be developed for the USI A-46 evaluation are described in Section 9. The four major types of documents are:

- Safe Shutdown Equipment List (SSEL) Report
- Relay Evaluation Report
- Seismic Evaluation Report
- Completion Letter

REASONS FOR CHANGES TO GIP, PART II, SECTION 1

Listed below are the specific reasons for making the changes marked with a vertical line in the margin of this section to create GIP-3A from GIP-3, Updated 5/16/97. The endnote numbers listed below correspond to the bracketed numbers (e.g., [1]) located in the text of this section where the changes are made.

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[1] Editorial clarification added.