March 23, 2012
Revision A

Outline of Seismic Walkdown Requirements

Purpose

The purpose of this document is to outline the key requirements to be addressed in the seismic walkdown procedures to be used by licensees for developing the information requested in the NRC 10CFR50.54(f) letter to address the Near-Term Task Force (NTTF) Recommend 2.3: Seismic [Ref. 1].

Based on the approach defined in the 50.54(f) letter, these walkdown requirements focus on "verifying current plant configuration with the current licensing basis" and identifying "degraded, non-conforming, or unanalyzed conditions." As requested in the 50.54(f) letter, the walkdown requirements are informed by the approach and lessons learned from the following existing NRC and industry processes:

- NRC report on the Summary of Observations from Inspection Reports based on Temporary Instruction 2515/183, "Follow-up to the Fukushima Dai-ichi Nuclear Station Fuel Damage Event"
- EPRI Report NP-6041-SL Revision 1, "A Methodology for Assessment of Nuclear Power Plant Seismic Margin"
- Seismic Qualification Utility Group procedure, "Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Power Plant Equipment"
- International Atomic Energy Agency NS-G-2.13, "Evaluation of Seismic Safety for Existing Nuclear Installations."
- NRC (E. Leads) letter to VEPCO (D. Heacock) dated November 11, 2011, Enclosure: North Anna Power Station, Units 1 and 2, Technical Evaluation Related to Plant Restart After the Occurrence of an Earthquake Exceeding the Level of the Operating Basis and Design Basis Earthquakes

Approach

The evaluation of the seismic adequacy of SSCs is based on a sampling of equipment identified during the Individual Plant Examination of External Events (IPEEE) program in the 1990's. In most cases, these SSCs were shown to be capable of fulfilling their safety related functions for seismic excitation beyond the plant design basis earthquake. Therefore, the purpose of the seismic walkdowns for NTTF 2.3 – Seismic is to confirm that these SSCs have not changed or degraded. A sampling approach, which focuses on the condition of the anchorage and potential seismic interactions of mechanical and electrical equipment, is therefore sufficient to meet these objectives. The NTTF 2.3 – Seismic walkdowns are not intended to update or revise the IPEEE

program. Instead, as discussed in Section 2 of the Detailed Outline, the scope of equipment identified during the IPEEE program for walkdowns is the starting point for identifying the scope of equipment to be evaluated during the NTTF 2.3 – Seismic walkdowns.

Detailed Outline

The following outline includes the key requirements for identifying the personnel requirements, the scope of equipment to be walked down, how to conduct the walkdown, and how to identify equipment that will require additional evaluations. Documentation requirements are also defined. Where appropriate, footnotes are used to clarify these requirements and in some cases to provide a technical basis for the approach used.

1. Personnel Qualifications

   The following three types of personnel who are involved in the seismic assessment should meet the following personnel requirements:

   a. System or Design Engineers

      i. System or design engineers, who will identify the scope of equipment described in Section 2 below, should be familiar with the documentation associated with:

         (1) The success paths or cut sets of equipment walked down during the IPEEE program.

         (2) The equipment identified as anomalies, outliers, or other findings identified during the IPEEE program.

         (3) The equipment added or modified subsequent to completion of the IPEEE program within the success paths or cut sets of equipment.

         (4) The systems and equipment associated with the spent fuel pool (SFP) which could potentially result in drain down of the SFP, e.g., connected piping.

      ii. No special training requirements apply.

   b. Seismic Walkdown Engineers

      i. Seismic walkdown engineers (SWEs), who will perform the seismic walkdowns described in Section 3 below, should meet the following requirements:

         (1) Have a degree, or equivalent, in mechanical or civil/structural engineering.

(2) Have experience in seismic engineering as it applies to nuclear power plants.

(3) Have completed one of the following two training courses:

(a) NTTF 2.3 Seismic Walkdown Training Course[1].

(b) SQUG Walkdown Training Course.

ii. Seismic walkdowns are to be conducted by teams of engineers, each of which includes at least two SWEs with support, as needed, from other personnel, e.g., system/design engineers, operators, or maintenance personnel. The licensee may use as many teams as they deem necessary.

iii. Both of the SWEs on each of the seismic walkdown teams must agree with the conclusions reached during the evaluation.

2. Identify Scope of Equipment

The equipment to be identified for evaluation during the seismic walkdown should include the following elements:

a. A sample (~100)[2] of mechanical and electrical equipment[3] that was walked down during the IPEEE program[4]. Equipment within other equivalent success paths or cut sets may be included in the sample, even if that equipment had not been walked down during the IPEEE program. This sample should include:

i. At least one item of equipment from each of the 21 classes of mechanical and electrical equipment shown in Attachment 1. Only those classes of equipment that had been walked down during the IPEEE program need be included.

ii. Mechanical and electrical equipment that was added to or modified within the success paths or cut sets in the IPEEE program since the IPEEE program had been completed[5].

b. Improvements made as part of the licensees' response to the IPEEE program for seismic issues.

c. Equipment and systems connected to the spent fuel pool (SFP), which if they ruptured or malfunctioned, could rapidly drain the SFP. Rapid draining is defined as a leak path that could expose the top of the fuel assemblies in less than 72 hours[6]. Potential drain paths could include piping, valves, and equipment connected to those systems.

d. Document the results of the selection of equipment.

3. Conduct Seismic Walkdowns

The seismic walkdowns of the equipment within the scope of review should include the following elements. It is expected that seismic walkdown engineers will be using their engineering judgment, based on their experience and training. The engineers may also rely upon new or existing analyses, where needed, to inform their judgment.

a. Locate Equipment

i. Locate within the plant each item of equipment identified in Section 2 above.

ii. If an item is not accessible or its anchorage cannot be viewed due to plant operating conditions, report this back to the project manager, who will determine whether a comparable or similar item can be walked down instead. If a suitable alternative cannot be identified and none of the evaluation methods described in Section 3can be used, then document that situation in the summary report of the seismic walkdown. It is not necessary to evaluate such inaccessible equipment further, provided is it does not constitute more than 20% of the sample (i.e., about 20 items).

b. Equipment Anchorage

i. Evaluate the equipment anchorage for degraded, non-conforming, or unanalyzed conditions using one or more of the following methods as appropriate[7]:

(1) Determine whether the anchorage has any of the following attributes:

(a) Bent, broken, missing, or loose hardware

(b) Excessive corrosion

(c) Other adverse concerns

(2) Review previous walkdown packages (e.g., USI A-46 SEWS, IPEEE Checklists, Maintenance Rule Inspections, QA installation records) and verify that the installation was reviewed.

(3) Observe the local environment for evidence of potential causes for deterioration. For example, look for moisture in the area and corrosion of other nearby components; look for local sources of vibration that could loosen fasteners.

(4) Check whether the equipment and its anchorage have been modified since it was last walked down.

ii. If in the judgment of the SWEs the anchorage of an item of equipment may not be robust, document that conclusion and perform further evaluations using the guidance in Section 4 below.

c. Seismic Interaction

i. Screen the equipment and its surroundings for the following three types of seismic interactions[8].

(1) Seismic Spatial Interactions – Visually verify that any soft, vulnerable targets on the subject equipment are free from credible impact due to relative motion with nearby equipment, systems, or structures.

This evaluation should include verifying that good housekeeping practices are being used, e.g., cabinet doors not left open without operators nearby, portable and mobile equipment are not routinely parked/stored near safety related equipment, etc.

A seismic spatial interaction evaluation should also be conducted in the vicinity of the spent fuel pool (SFP) to verify that components, equipment, and systems will not fall into the SFP.

(2) Seismically Induced Fire Interactions – Visually verify that any potential sources of fire (e.g., compressed flammable gas bottles, fuel tanks, other combustible material, etc.) located in the vicinity of the subject equipment have adequate support and are not likely to become a source of a fire due to seismic motion.

(3) Seismically Induced Flooding/Spray Interactions – Visually verify that potential sources of water (e.g., fire suppression piping, tanks, etc.) located in the vicinity of the subject equipment have adequate support and load path so that they are not a likely to be a source of flooding or spray that could adversely affect the subject item of equipment.

ii. If an item of equipment has one or more adverse seismic interactions, document that conclusion and perform further evaluations using the guidance in Section 4 below.

d. Modifications to Address Anomalies, Outliers, or Other Findings Identified during IPEEE Program

i. Verify that the IPEEE program commitments to modify equipment have been met and modifications have been implemented.

ii. If any of the planned modifications has not been implemented, document that conclusion and perform further evaluations using the guidance in Section 4 below.

e. Spent Fuel Pool Drainage

i. Evaluate piping and connected equipment for degraded, non-conforming, or unanalyzed conditions using the methods described in Sections 3.b and 3.c for potential seismic failure modes that could cause the SFP to drain rapidly.

ii. If in the judgment of the seismic walkdown engineers any of this piping or equipment might cause the SFP to drain quickly, document that conclusion and perform further evaluations using the guidance in Section 4 below.

f. Documentation

i. Document the results of the seismic walkdowns and evaluations for the equipment and systems within the scope of review defined in Section 2 on completed, signed checklists[9].

ii. Both seismic walkdown engineers on each walkdown team must agree with the results and conclusions of the seismic evaluation and signify that concurrence by signing the checklists.

4. Resolution of Items Requiring Further Evaluation.

a. If an item of equipment does not pass one or more of the evaluation screens defined in Sections 3.b through 3.e, then:

i. Identify the plant licensing basis[10] for the seismic qualification of that item of equipment.

ii. Locate the seismic qualification documentation[11] for that item of equipment.

iii. Determine whether that item of equipment, as installed in the plant, meets its seismic qualification licensing basis. One of the following three outcomes may occur from this evaluation. The action required for each outcome is also provided:

(1) The seismic qualification licensing basis is met: No further action is required.

(2) The seismic qualification licensing basis is not met: Enter the plant corrective action program for disposition.

(3) There is no seismic qualification licensing basis[12]: Evaluate the plant-specific situation for possible additional evaluation.

b. Document the results of the additional evaluations.

5. Submittal Report

A report should be prepared to submit to the NRC staff to describe the results of the NTTF Recommendation 2.3 seismic walkdowns. This report should include the following information:

a. Overall description of the seismic walkdown guidelines and procedure used and any exceptions taken.

b. The bases for and results of the selection of equipment identified for the seismic walkdowns.

c. Summary of the results of the seismic walkdowns.

d. Listing of the equipment items that could not be inspected due to inaccessibility.

e. Summary of the items that required further evaluations and the results of those evaluations. For evaluations that have not been completed or with outcomes requiring further actions, include a schedule for these actions.

f. Description of the actions taken or planned to address any deviations from the plant licensing basis that were identified during this seismic review. This description should be consistent with the guidance in Regulatory Issues Summary 2005-20, Rev. 1, Revision to NRC Inspection Manual Part 9900 Technical Guidance, "Operability Conditions Adverse to Quality or Safety."

g. Listing of the seismic walkdown engineers including a copy of their training certificates.

Footnotes

[1] The curriculum for the NTTF 2.3 Seismic Walkdown Training Course will be based on the requirements in the walkdown procedure and include guidance for judging whether equipment anchorage is seismically adequate and for identifying potential adverse seismic interactions.

[2] The scope of mechanical and electrical equipment identified for review during IPEEE ranged from about 500 to 1000 items of equipment. Since this equipment had been walked down during the IPEEE program and evaluated for beyond design basis seismic loadings, it is considered reasonable to limit the scope of the NTTF 2.3 seismic review to a sample of about 10% but less than 15% of this equipment. Such a sample size is adequate to confirm that the key characteristics of this equipment have not changed or degraded since the IPEEE program was completed.

[3] The scope of review for NTTF is limited to mechanical and electrical equipment that must perform a function to safely shut down the plant. The basis for this limited scope is that the vast majority of seismic failures during earthquakes is attributed to missing, inadequate, or deteriorated anchorage of equipment (see page 24 in the Regulatory Analysis for GL 87-02, Resolution of USI A-46 [Ref. 1]). Further, based upon the results of the USI A-46 and IPEEE programs, passive equipment, such as piping, structures, and NSSS equipment were not identified as significant sources of seismic vulnerabilities in nuclear power plants.

[4] Limiting the scope of equipment to those items identified in the IPEEE program is considered reasonable. All licensees were required to develop a list of equipment to be walked down during the IPEEE program.

[5] As discussed in Footnote 2, the basis for limiting the scope of the walkdown to a sample is that the equipment had been walked down during IPEEE. Since new and replacement equipment within the IPEEE success paths or cutsets had not been walked down, they are included in the scope of review. Lessons learned from USI A-46 and IPEEE, showed that seismic walkdowns by experienced, trained engineers are effective in identifying seismic vulnerabilities.

[6] The review of the spent fuel pool (SFP) is limited to piping systems and associated components that could allow the SFP to drain rapidly and expose the top of the spent fuel assemblies in less than about 72 hours. It is anticipated that smaller leakage can be made up for long-term maintenance of SFP inventory.

[7] The seismic adequacy of equipment anchorage is the prime evaluation criteria since the vast majority of seismic failures during earthquakes is attributed to missing, inadequate, or deteriorated anchorage of equipment. The NRC also came to this conclusion during their regulatory analysis of the USI A-46 program as seen on page 24 in the Regulatory Analysis for GL 87-02 [Ref. 1]. It is judged that the walkdown screening criteria defined in Section 3.b are adequate to identify missing, inadequate, or deteriorated anchorage of equipment.

[8] Guidelines for evaluating potential adverse seismic interactions may be based on the Appendix F of Seismic Margin Evaluation method defined in EPRI NP-6041 [Ref. 5].

[9] Walkdown checklist to be developed will be similar to those used for resolution of USI A-46 [e.g., Ref. 3] and IPEEE [e.g., Ref. 5].

[10] The plant licensing basis is for seismic qualification of equipment is typically located in the following sections of the FSAR:

- Section 3.2.1, Seismic Classification
- Section 3.7.1, Seismic Design Parameters
- Section 3.7.2, Seismic Systems Analysis
- Section 3.7.3, Seismic Subsystem Analysis
- Section 3.7.4, Seismic Instrumentation
- Section 3.9.2, Dynamic Testing and Analysis of Systems, Components, and Equipment
- Section 3.10, Seismic and Dynamic Qualification of Mechanical and Electrical Equipment

[11] Seismic qualification documentation may include seismic analyses, shake table test results, and the results of the USI A-46 program (e.g., SEWS checklists).

[12] A seismic qualification design basis may not be available for some non-safety related equipment (e.g., spent fuel pool cooling equipment).

References

1. SECY-12-0025, Enclosure 7, NRC 10CFR50.54(f) Letter, Enclosure 3, Recommendation 2.3: Seismic

2. NUREG-1211, regulatory Analysis for Resolution of Unresolved Safety Issue A-46, Seismic Qualification of Equipment in Operating Plants, USNRC, February 1987.

3. "Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment," Revision 3A (GIP-3A), Seismic Qualification Utility Group (SQUG), December 2001.

4. EPRI NP-7149-D, "Summary of the Seismic Adequacy of Twenty Classes of Equipment Required for the Safe Shutdown of Nuclear Plants," March 1991.

5. EPRI NP-6041-SL, Revision 1, "A Methodology for Assessment of Nuclear Power Plant Seismic Margin (Revision 1)," Electric Power Research Institute, August 1991.

Attachment 1

Classes of Mechanical and Electrical Equipment
[Adapted from Table A-1 of EPRI NP-6041 (Ref. 5)]

1. Motor Control Centers and Wall-Mounted Contactors
2. Low Voltage Switchgear and Breaker Panels
3. Medium Voltage, Metal-Clad Switchgear
4. Transformers
5. Horizontal Pumps
6. Vertical Pumps
7. Pneumatic-Operated Valves
8. Motor-Operated and Solenoid-Operated Valves
9. Fans
10. Air Handlers
11. Chillers
12. Air Compressors
13. Motor Generators
14. Distribution Panels and Automatic Transfer Switches
15. Battery Racks
16. Battery Chargers and Inverters
17. Engine Generators
18. Instrument Racks
19 Temperature Sensors
20. Instrument and Control Panels
21. Tanks and Heat Exchangers