3.10 SEISMIC QUALIFICATION OF SEISMIC CATEGORY I INSTRUMENTATION AND ELECTRICAL EQUIPMENT

This section presents information to demonstrate that instrumentation and electrical equipment classified as seismic Category I is capable of performing safety-related functions in the event of an earthquake.

Seismic Category I instrumentation and electrical equipment is identified in Table 3.10-1. Electrical equipment that is not designed to seismic Category I criteria and whose structural failure could affect the operation of seismic Category I equipment is located, physically restrained, or structurally designed, such that its postulated structural failure during seismic conditions does not prevent Category I electrical equipment from performing its safety function.

3.10.1 Seismic Qualification Criteria

3.10.1.1 Qualification Standards

The methods of meeting the general requirements for seismic qualification of Category I instruments and electrical equipment as described by General Design Criteria (GDC) 1, 2, and 23 are described in Section 3.1. The general methods of implementing the requirements of Appendix B to 10CFR Part 50 are described in Section 17.

The seismic Category I instrumentation and electrical equipment and their supports as listed in Table 3.10-1 are qualified in accordance with the methods described in IEEE Standard 344-1971.

The seismic acceleration levels used in the seismic qualification tests and analyses are selected to envelope the plant specific levels defined in Section 3.7.

3.10.1.2 Acceptance Criteria

Seismic qualification must demonstrate that Category I instrumentation and electrical equipment is capable of performing designated safety-related functions during and after an earthquake of magnitude up to and including the Safe Shutdown Earthquake (SSE). The qualification must also demonstrate the structural integrity of mechanical supports and structures at the Operating Basis Earthquake (OBE) level. Some permanent mechanical deformation of supports and structures is acceptable at the SSE level provided that the ability to perform the designated safety-related functions is not impaired.

3.10.2 Methods and Procedures for Qualifying Electrical Equipment

The seismic qualification of Seismic Category I instrumentation and electrical equipment is demonstrated by testing, analysis, or a combination of these methods in accordance with IEEE Standard 344-1971. The choice of qualification method employed for a particular item of equipment is based upon many factors including: practicability, complexity of equipment, function of equipment, and availability of previous seismic qualification. The qualification method employed for a particular item of equipment is identified in Table 3.10-1.

3.10.2.1 Seismic Qualification by Type Test

From 1969 to mid-1974, Westinghouse seismic test procedures employed single axis sine beat inputs in accordance with IEEE Standard 344-1971 to seismically qualify equipment. The input form selected by Westinghouse was chosen following an investigation of building responses to seismic events (1). In addition, Westinghouse has conducted seismic retesting of certain items of equipment as part of the Supplemental Qualification Program (2). This retesting was performed at the request of the NRC Staff on agreed selected items of equipment employing

multi-frequency, multi-axis test inputs (3) to demonstrate the conservatism of the original sine beat test method with respect to the modified methods of testing for complex equipment recommended by IEEE Standard 344-1975. The original single axis sine beat testing (4) and the additional retesting completed under the Supplemental Test Program has been the subject of generic review by the NRC Staff.

Balance-of-plant (BOP) equipment was tested in accordance with IEEE Standard 344-1971.

3.10.2.2 Seismic Qualification by Analysis

Employing motors as an example, the structural integrity of safety-related motors is demonstrated by a static seismic analysis in accordance with IEEE Standard 344-1971. Motor operability during a seismic event is demonstrated by calculating critical deflections, loads, and stresses under various combinations of seismic, gravitational, and operational loads. The worst case (maximum) calculated values are tabulated against the allowable values. On combining these stresses, the most unfavorable possibilities are considered in the following areas: 1) maximum rotor deflection, 2) maximum shaft stresses, 3) maximum bearing load and shaft slope at the bearings, 4) maximum stresses in the stator core to frame welds, 5) maximum stresses in the motor mounting bolts and, 6) maximum stresses in the motor feet.

The analytical models employed and the results of the analysis are described in the qualification references.

3.10.2.3 Seismic Qualification by a Combination of Type Test and Analysis

A combination of test and analysis is employed in the qualification of equipment such as a cabinet that may house several different configurations of devices. This method is also used for multiple joined equipment. A test is performed on the

device supporting structure (e.g., cabinet) and an analysis model is then developed to perform a structural evaluation of different configurations. The test is utilized in the development and refinement of the analytical model and provides a verification of the analytical results. When needed, tests are performed on devices with applicable device seismic environments determined by the analytical model.

3.10.3 Methods and Procedures for Qualifying Supports of Instrumentation and Electrical Equipment

The seismic qualification of the supports for Category I instrumentation and electrical equipment is demonstrated by testing, analysis, or a combination of these methods. The preferred method of qualification for these supports is to test the support with the equipment as described above. When testing is not practical, qualification of supports is by static and/or dynamic analysis procedures; the possible amplified design loads for vendor supplied equipment are considered as follows:

1. The support is tested with the actual components mounted or with the component loads simulated.

2. Analysis of the support includes the component loads.

3.10.4 Results of Tests and Analyses

The results of the seismic tests and analyses that ensure the criteria established in Section 3.10.1 have been satisfied, employing the qualification methods described in Sections 3.10.1 and 3.10.3, are provided in individual seismic qualification reports. These reports are referenced in Table 3.10-1.

3.10.5 References for Section 3.10

1. Morrone, A., "Seismic Vibration Testing with Sine Beats," WCAP-7558, October 1971.

2. NS-CE-692, letter from C. Eicheldinger (Westinghouse) to D. B. Vasello (NRC), July 10, 1975.

3. Jarecki, S. J., "General Method of Developing Multi-frequency Biaxial Test Inputs for Bistables," WCAP-8624 (Proprietary), September 1975 and WCAP-8695 (Non-Proprietary), September 1975.

4. Vogeding, E. L., et al, "Seismic Testing of Electrical and Control Equipment (Low Seismic Plants)." WCAP-7397-L (Proprietary) and WCAP-7817 (Non-Proprietary), December 1971, plus Supplements 1-8.