Entergy

**Entergy Nuclear Generation Co.**
Pilgrim Nuclear Power Station
600 Rocky Hill Road
Plymouth, MA 02360

**Mike Bellamy**
Site Vice President

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U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Docket No. 50-293
License No. DPR-35

Subject: Response to NRC October 13, 1999, RAI Regarding GL 87-02 USI A-46

This letter responds to the NRC October 13, 1999, request for additional information regarding the schedule of remaining USI A-46 outliers and for additional building specific information regarding the use of GIP Method A.1. The requested information is provided as an attachment.

Should you have any further questions or concerns, please do not hesitate to contact us.

This letter contains schedule commitments relative the completion of remaining USI A-46 outliers.

Sincerely,

Mike Bellamy

Attachment

cc: Mr. Alan B. Wang, Project Manager
Project Directorate I-3
U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Mail Stop: OWF 8F2
1 White Flint North
11555 Rockville Pike
Rockville, MD 20852

U. S. Nuclear Regulatory Commission
Region 1
475 Allendale Road
King of Prussia, PA 19406

Senior Resident Inspector
Pilgrim Nuclear Power Station

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RAI Question 1

What is the status of all identified outliers for USI A-46 resolution? For those outliers that have not been implemented, please provide a completion schedule.

Response

References:

1. Boston Edison Company Letter 96-085 dated September 30, 1996, "Summary Report, Generic Letter 87-02, Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46"
2. Boston Edison Company Letter 98-045 dated June 15, 1998, "Response to Request for Additional Information Re. Pilgrim's USI A-46 Implementation"

The Pilgrim Nuclear Power Station (PNPS) scope for outlier resolution is composed of two distinct components. These are as follows:

A) Outliers associated with the September 30, 1996 submittal to NRC (Reference 1).

B) Outliers associated with the June 15, 1998 submittal to NRC (Reference 2).

The Reference 1 submittal reflected those outliers identified utilizing the Seismic Qualification Utility Group (SQUG) Method A guidance in effect at the time of the submittal. SQUG guidance had the seismic acceleration applied at the ground surface. The Reference 2 submittal, a response to a NRC RAI, had the seismic acceleration applied at the foundation level of site structures. This is in accordance with the revised SQUG guidance which resulted from SQUG/NRC discussions on Method A.

The following represents the status for closure of PNPS USI A-46 outliers.

A) Original USI A-46 Scope

Total Equipment Modifications = 52
Equipment Modifications Complete = 39
Equipment Modifications Remaining = 13

Schedule

Of the 13 remaining equipment modifications, 11 are currently planned for on-line implementation and 2 require shutdown conditions for implementation. The 2 requiring a plant shutdown are planned for completion during the next refueling outage (RFO 13) scheduled to commence approximately April 2001. The remaining 11 on-line modifications are planned to be implemented prior to RFO 13. All relay work requiring replacement is completed.

B) Revised Method A Outlier Scope

After application of the revised SQUG Method A guidance, 19 additional outliers were identified. No relays were within this population. At present, 6 of these new outliers have been resolved and 5 will likely result in a modification. The remaining identified outliers are being assessed for resolution. By March 1, 2000, our schedule for final resolution will be available for transmittal to your offices.

RAI Question 2

The Generic Implementation Procedure, Revision 2 (GIP-2), provides for several methods of comparing seismic capacity to seismic demand. Method A.1 compares the SQUG Bounding Spectrum to the plant's safe shutdown earthquake (SSE) ground response spectrum. However, GIP-2 places limitations on the use of Method A.1. These limitations are that the SSE ground response spectrum can be used for comparison to the Bounding Spectrum when:

- The equipment is mounted in the nuclear plant at an elevation below about 40 feet above the effective grade.
- The equipment, including its supports, has a fundamental natural frequency greater than about 8 Hz.
- The amplification factor between the free field ground response spectrum (GRS) and the in-structure response spectra (IRS) is not more than about 1.5.

In your letter entitled "USI A-46 Supplementary Information," dated August 6, 1999, Figures 1, 2, 3 and 4 contain plots of the IRS and GRS for the Reactor Building at elevation 23 feet, the Turbine Building at elevation 37 feet, the Radwaste Building at elevation 37 feet and the Diesel Generator Building at elevation 34.5 feet. You used GIP-2 Method A.1 to compare the seismic demand to seismic capacity for safe shutdown equipment list items at these locations. However, the amplification factors above 8 Hz, of these IRS with respect to the GRS appear to be significantly above the 1.5 limit set by GIP-2. Provide a building specific quantitative justification for the use of Method A.1 at the locations where the amplification exceeds the 1.5 limit above 8 Hz.

Response

References:

1. Entergy Letter to NRC, "USI A-46 Supplementary Information" dated August 6, 1999.
2. Senior Seismic Review and Advisory Panel (SSRAP), "Use of Seismic Experience and Test Data to Show Ruggedness of Equipment in Nuclear Power Plants," Revision 4.0, February 28, 1991.
3. Safety Evaluation by The Office of Nuclear Reactor Regulation, "Evaluation of Rochester Gas and Electric Corporations Response to Supplement No. 1 to Generic Letter 87-02, Ginna Nuclear Power Plant, Docket No. 50-244".

Conservatism's associated with the analytical procedures used in the development of design basis in-structure response spectra (ISRS) produce conservative spectral accelerations which, for elevations within 40 feet above the effective grade, are higher in amplitude than 1.5 times the licensing basis free-field response spectrum. However, estimated realistic median-centered ISRS values for Pilgrim Nuclear Power Station (PNPS) buildings do not greatly exceed 1.5 times the licensing basis free-field response spectrum for frequencies over 8 Hz. This result, using estimated median-centered ISRS, is consistent with the basis for application of Method A.1, as developed by the Senior Seismic Review and Advisory Panel (SSRAP) (Reference 2).

The following discussion restates and supplements information previously furnished in Reference 1. The basis for concluding Method A.1 is applicable to PNPS buildings is presented. Conservatisms in the PNPS analytical procedures used in the development of design basis ISRS are presented. Building specific factors of conservatism, expressed as the ratio of conservative PNPS design basis ISRS to realistic median centered spectra, are estimated, and the associated median-centered ISRS to ground response spectrum (GRS) amplification factors are calculated.

Buildings Housing SSEL Components Using Method A.1

The buildings housing Safe Shutdown Equipment List (SSEL) components at PNPS are typical of nuclear plant construction for which the SSRAP estimated amplification factor of 1.5 is applicable.

The Reactor Building (RB) is an embedded, multi-story reinforced concrete shear wall structure up to the operating floor at elevation 117 feet. The foundation consists of an 8 foot thick heavily reinforced concrete mat, founded on undisturbed soil approximately 42 feet above the bedrock elevation. The elevation of the top of the mat is elevation (–)17.5 feet, which is approximately 40 feet below the site grade. The effective grade for A-46 implementation is the foundation elevation, and the highest floor using GIP Method A is elevation 23 feet.

The Turbine Building (TB) is an embedded multi-story braced steel frame structure with interior reinforced concrete shear walls up to the turbine deck. The structure is founded on approximately 10 feet of compacted structural backfill over undisturbed soil. The top of the foundation is elevation 6 feet, which is approximately 16 feet below the site grade. The effective grade for A-46 implementation is the TB foundation elevation, and the highest floor using GIP Method A is elevation 37 feet.

The Radwaste Building (RWB) is an embedded, multi-story reinforced concrete shear wall structure. The structure is founded on compacted backfill over undisturbed soil. The top of the mat is elevation (–)1 feet, which is approximately 23 feet below the site grade. The effective grade for A-46 implementation is the foundation elevation, and the highest floor using GIP Method A is elevation 37 feet.

The Diesel Generator Building (DGB) is a reinforced concrete frame and shear wall structure. The top of the foundation is at plant grade, elevation 23 feet. The highest elevation at which Method A was used is elevation 34.5 feet.

Factors of Conservatism in PNPS Design Basis ISRS

Calculated ISRS have never been portrayed as representing the realistic expected response during an actual earthquake. ISRS typically contain many conservatisms which make them unrealistically high. The primary reason for the development of Method A was to define a more median-centered method of establishing structural response without having to embark on costly new analyses of all site buildings. Estimates of the conservatism of PNPS design basis ISRS can be used to calculate estimated realistic median-centered ISRS.

The most significant sources of conservatism involved in the development of the ISRS for PNPS include the following:

- Soil-Structure Interaction (soil damping, wave scattering effects)
- Structural Damping
- Ground Motion Incoherence
- Time History Simulation
- Peak Broadening and Enveloping
- Clipping of Narrow Peaks

Estimated conservatism, expressed as the ratio of conservative PNPS design basis ISRS to realistic median-centered spectra, were previously provided in a table presented in Attachment A-1 of Reference 1. The table containing these factors of conservatism for each of the various sources is repeated below with the addition of a resultant factor estimated as the square-root-of-the-sum-of-the-squares (SRSS) of the individual contributors.

| Building | RB | TB | RWB | DGB |
|---|---|---|---|---|
| SSI and Damping | 3.0 | 3.0 | 3.0 | 2.0 |
| GM Incoherence | 1.5 | 1.5 | 1.2 | 1.1 |
| Time History | 1.5 | 1.5 | 1.0 | 1.5 |
| Peak Broadening | 1.2 | 1.2 | 1.0 | 1.0 |
| Peak Clipping | 1.0 | 1.0 | 1.1 | 1.0 |
| Resultant Factor (SRSS)* | 3.86 | 3.86 | 3.41 | 2.73 |

*Resultant factor is calculated using only individual contributors having a value >1.0

These results are similar to a comparison evaluation of overall seismic margins between design basis and median-centered analysis for nuclear power plant structures at various facilities. Information developed by EQE International, Inc., under the auspices of the SQUG, demonstrates that factors of conservatism in original design basis analyses can be shown to be in the range of 2.5 to 5 (Refer to Table 1 in Attachment A-1 of Reference 1). The structures in that table are reinforced concrete shear wall structures with frequencies in the range of 7 to 13 Hz. Explicit factors of conservatism are seen to range from 2.3 to 5.4. A mean value of the factor of conservatism for these particular results has been calculated by the NRC staff as 3.77 in Reference 3.

## Building Specific Amplification Factors

Building specific amplification factors, expressed as the ratio of realistic median-centered ISRS to the GRS, can be estimated for each PNPS building. This is performed here using a factor of conservatism for the RB and TB based on the 3.77 mean value calculated by the NRC staff (Reference 3) and for the RWB and DGB, the lower result estimated above from the qualitative data submitted in Reference 1 (i.e., RWB: 3.41 and DGB: 2.73).

The following building specific amplifications factors are calculated using the 5% damped PNPS licensing basis spectral acceleration digitized data published in BECo Specification C-114 for each of the associated buildings and for the ground spectrum:

RB: The ISRS at elevation 23 feet compared to the GRS shows the maximum amplification is about 2.85 or less above 8 Hz. Dividing this value by 3.77 to obtain the ratio of the estimated realistic median-centered ISRS to the GRS results in an amplification factor of 0.76.

TB: The ISRS for elevation 37 feet compared to the GRS shows a maximum amplification of about 8.37 at 8 Hz and about 6.65 or less above 9 Hz. Dividing these values by 3.77 to obtain the ratio of the estimated realistic median-centered ISRS to the GRS results in an amplification factor of 2.22 at 8 Hz. and 1.76 or less above 9 Hz.

RWB: The ISRS for elevation 37 feet compared to the GRS shows the maximum amplification above 8 Hz is about 5.32 at 14 Hz. Dividing this value by 3.41 to obtain the ratio of the estimated realistic median-centered ISRS to the GRS results in an amplification factor of 1.56.

DGB: The ISRS for elevation 34.5 feet compared to the GRS shows the maximum amplification above 8 Hz is about 2.42 at 12 Hz. Dividing this value by 2.73 to obtain the ratio of the estimated realistic median-centered ISRS to the GRS results in an amplification factor of 0.89.

## Conclusion

Consideration of the above indicates there are large factors of conservatism in the PNPS licensing basis ISRS. Specific exceedances noted for PNPS design basis ISRS beyond the 1.5 factor are due to the conservatisms inherent in the ISRS calculation methods and do not invalidate the application of Method A. If these factors of conservatism are taken into account, the judgment of the PNPS USI A-46 Seismic Review Team that the PNPS structures are "typical nuclear plant" structures for which GIP Method A is applicable is seen to be reasonable. If detailed analyses were performed and realistic, median-centered ISRS were actually calculated for the elevations at which Method A was used in these structures, the amplification of the ISRS over the free field GRS would not greatly exceed 1.5 at frequencies above 8 Hz.