January 10, 1985

Docket No. 50-293

Mr. William D. Harrington
Senior Vice President, Nuclear
Boston Edison Company
800 Boylston Street
Boston, Massachusetts 02199

Dear Mr. Harrington:

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION CONCERNING MASONRY WALL DESIGN FOR PILGRIM STATION

Upon reviewing the information concerning the design of masonry walls at Pilgrim Station, which was provided during a meeting on July 19, 1984, we have identified several items which require clarification. The enclosure provides the topics or questions to be addressed.

Please provide the additional information within 45 days after receipt of this request.

The reporting and/or recordkeeping requirements contained in this letter affect fewer than ten respondents; therefore, OMB clearance is not required under P.L. 96-511.

Sincerely,

/s/ D. B. Vassallo

Domenic B. Vassallo, Chief
Operating Reactors Branch #2
Division of Licensing

Enclosure:
As stated

cc w/enclosure:
See next page

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Mr. William D. Harrington
Boston Edison Company
Pilgrim Nuclear Power Station

cc:

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REQUEST FOR ADDITIONAL INFORMATION
MASONRY WALL DESIGN, IE BULLETIN 80-11
PILGRIM NUCLEAR POWER STATION
DOCKET NO. 50-293

Based on the information provided by the licensee during the meeting at the NRC office in Bethesda, MD on July 19, 1984, the following topics require further clarification and/or responses:

A. Statistical Analysis of Boundary Strengths

1. With respect to the sampling technique used in the test verification program, please provide a technical assessment of the use of unequal exposed lengths for anchor verification in different walls. Also provide a technical assessment of the fact that the exposed length was not related to the length of the wall (i.e., total of 48 in of exposure was applied not only for a short wall, say an 8-ft. wall, but also for a long wall, say a 20-ft. wall or longer).

2. In a few cases, no anchors were found with a predetermined exposed length. The licensee should extend this exposed length to locate the anchors. The results will help to reinforce the adequacy of the statistical analysis method.

B. Orthotropic Plate Analysis

Based on the summary of finite element analysis and sample calculations of wall 63.4, 65.8, 64.4, and 188.10 given in the meeting on July 19, 1984, the following questions are presented:

1. CYGNA's methodology call for two-way cracked analysis of block walls (level I and level II). There are no acceptable methods available in the literature for the bending analysis of block masonry walls in the post-cracking stage. This is primarily because of the complexity of the problem due to material anisotropy [1], the existence of planes of weakness which affect crack propagation [2], discontinuity due to partial grouting, and the uncertainty about the contribution of joint reinforcement in the lateral load resistance [3]. In light of the above comments, justify two-way cracked analysis.

2. Equations developed for adequately reinforced concrete slabs have been used in the analysis to account for the orthotorpic properties resulting from differing steel reinforcement details in the vertical and horizontal directions. The applicability of these equations to block masonry walls is questionable because of the notable differences between a reinforced concrete slab and a block masonry wall. First, concrete is a globally homogeneous material, whereas masonry is not [4]. This is particularly true for partially grouted walls. Secondly, the percentage of reinforcement and detailing in the two directions are quite different in the two cases. Steel orthotropy for which these equations were developed is not applicable for the Pilgrim walls which have no horizontal steel. Thirdly, because masonry is a jointed

medium, one expects crack patterns, and consequently the steel contribution, to be different from those in reinforced concrete. In light of these comments, justify the use of equations developed for the reinforced concrete slab to qualify the masonry walls.

3. Modulus of elasticity of the walls is assumed to be equal in the two orthogonal directions. This is not true for masonry which is a composite material [2]. Assessment of the accuracy of this assumption and its impact on the outcome of the analysis needs to be investigated.

4. The Branson equation [5] has been used in level II analysis to determine the effective moment of inertias of different elements. This empirical equation was originally developed for reinforced concrete members under uniaxial bending. Its applicability to two-way bending of block masonry walls needs to be demonstrated. It must be noted that the Branson equation has been used to express effective moment of inertia in the horizontal direction where there is no reinforcing steel.

5. Higher damping values have been used in level II analysis. What is the basis for choosing higher damping values? Are these values changing with the level of loading?

6. Review of calculations of wall 64.4/65.8 revealed a significant difference in element moments from level I and level II analyses. For example, moments in the critical element of the bond beam were reduced by 88% shifting from level I to level II analysis. How could this reduction be justified and what are the main reasons for such a large change?

7. Wall 188.10 has an aspect ratio greater than 3, which calls for almost a single curvature with bending primarily in the shorter direction. The crack pattern (parallel to the shorter direction), which is predicted from the computer analysis, does not seem to be consistent with the one-way bending action of the wall. This inconsistency does not provide confidence in the capability of the proposed analytical model to predict actual behavior.

8. It is not clear how existing cracks (e.g, in wall 64.4) have been accounted for in the analysis.

REFERENCES

1. Hamid, A. A. and Drysdale, R. G., "Failure Criteria of Masonry Under Biaxial Stresses," Journal of the Structural Division, Proceedings of ASCE, Vol. 107, ST8, August 1981.

2. Hamid, A. A. and Drysdale, R. G, "Concrete Masonry Under Combined Shear and Compression Loadings," Proceedings of the Journal of the American Concrete Institute, Vol. 77, No. 5, September-October 1981.

3. Harris, H. G., Hamis, A. A., Becica, I. J., Con, V., and Chokshi, N., "The Use of Joint Reinforcement in Qualifying Masonry Walls in Nuclear Power Plants," Proceedings of ASCE Specialty Conference-Structural Engineering in Operating Nuclear Power Facilities, Raleigh, NC, September 1984.

4. Hamid, A. A., "Behavioral Characteristics of Concrete Masonry," PH.D. Thesis, McMaster University, Hamilton, Ontario, Canada, 1978.

5. ACI Committee 435, "Deflection of Reinforced Concrete Flexural Members," ACI Manual of Concrete Practice, Part 2, American Concrete Institute, Detroit, MI, 1979.