

John D. O'Toole
Vice President

Consolidated Edison Company of New York, Inc.
4 Irving Place, New York, NY 10003
Telephone (212) 460-2533

February 24 , 1982

Re: Indian Point Unit No. 2
Docket No. 50-247

Director of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTN: Mr. Steven A. Varga, Chief
Operating Reactors Branch No. 1
Division of Licensing

Dear Mr. Varga:

Attachment A to this letter provides the information requested by your letter of December 22, 1981 regarding Con Edison's actions in response to IE Bulletin No. 80-11.

Should you or your staff require any further information or clarification, please contact us.

Very truly yours,

John D. Toole



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Attachment A

Response to NRC's 12/22/81 Request
for Additional Information concerning
IE Bulletin 80-11 "Masonry Wall Design"

Consolidated Edison Company of New York, Inc.
Indian Point Unit No. 2
Docket No. 50-247
February, 1982

Request No. 1:

The licensee should clarify whether 1.05 or 1.1 will be used as the factor to account for multimode effects and should provide the technical basis for the choice.

Response:

The response spectrum method of analysis using the normal modes was adopted for all wall analyses. This procedure implicitly includes multimode effects and so a factor to account for these effects in a simplified model is not necessary. Therefore reference to this factor will be deleted from the criteria.

Request No. 2

Since the SEB criteria require that multiple wythe and composite masonry analyses be reviewed on a case-by-case basis, the licensee should discuss the analytical approach and allowable stresses used for collar joints. With reference to the application of the results of Bechtel's 3/8-in collar joint test, the licensee should discuss the applicability to Indian Point Unit 2 of the Trojan test cited in the submittal.

Response:

The multi-wythe walls at the Indian Point plant are concrete block masonry in the Primary Auxiliary Building and brick walls in the Control Building. The concrete block multi-wythe walls were analyzed using the conservative approach of assuming single wythe response. Justification for this is provided as the response to Item 3.

The brick walls in the Control Building are three wythe units with header courses every sixth course. At the header courses the brick units are laid perpendicular to the other courses such that the bricks interlock between the adjacent wythes. Therefore the collar joint is formed of mortar plus the brick units every sixth course.

To evaluate the shear stresses between the wythes no account has been taken of the shear strength of the mortar collar joint. All shear has been assumed to be resisted by direct shear stresses in the header brick units. To obtain the shear force the total shear over six courses was obtained from the equation $v=VQ/lb$. This shear stress was then compared with the allowable value in the criteria for flexural shear.

Use of the flexural shear value is considered to be a conservative

approach because these values are based on the strength of specimens built up of units and mortar where the weakest section is through the mortar. Between the wythes the shear is such as to force the shear plane through the brick unit itself which is stronger than the mortar. In addition the collar joint will provide extra capacity which has not been taken into account in the evaluation.

As the allowable stresses in the collar joints were not utilized for any of the multi-wythe walls, the results of the Trojan test were not applied to any aspect of the Indian Point 2 wall evaluation.

Request No. 3

The licensee should justify the use of single wythe analysis for multiple wythe walls.

Response:

The effect of using a single wythe analysis for multi-wythe walls is a conservative approach. The gross section properties used to compute the moment of inertia and the section modulus to compute allowable moments are increased if it is assumed that the walls act compositely. As the section modulus is a function of the square of the depth this value and thus the allowable moment which is directly proportional to it, will be increased by a factor of four for double wythe walls and nine for triple wythe walls.

The stiffness increase of the wall gives a higher fundamental frequency of the wall. The most severe effect of this would be to move the wall response to the peak value of the envelope of the floor response spectra. However the amplification of the spectra used for Indian Point 2 is such that movement of the fundamental frequency would not cause an increase in loading as great as the increase in strength i.e., a minimum increase of 4. On this basis the use of single wythe analysis is judged to be conservative.

Request No. 4:

The licensee states that the Final Safety Analysis Report (FSAR) for the plant takes into account a two-direction (vertical and horizontal) earthquake. However, the analysis includes only the horizontal component of motion. SRP Section 3.7.1 requires design response spectra for three directions (one vertical and two orthogonal horizontal directions). The licensee should explain why the earthquake's vertical component was not considered.

Response:

All equipment on the Indian Point 2 masonry walls is rigid. Therefore vertical accelerations would not have any impact on the out-of-plane response of the walls because no moments would be induced by the equipment.

For the in-plane analysis, the compressive stresses have not been incorporated in the evaluation. Compression loads increase the capacity of masonry walls to carry shear forces. Therefore, neglecting the effects of these loads is conservative. The loads due to the weight of the wall and the attached rigid equipment will apply compression to the masonry unless a vertical acceleration in the upward direction exceeding 1 g occurs. The walls are very rigid in the axial direction and so the vertical accelerations in the wall would be equal to the zero period acceleration (ZPA) of the floor response spectra. None of the spectra for the Indian Point 2 plant have ZPA values approaching 1 g. Therefore, the wall would be in a compressive state of stress even with maximum vertical accelerations and so the shear strength would not be reduced.

For these reasons the vertical accelerations have not been included explicitly in the wall evaluation. Their effects have been considered implicitly and determined to have no detrimental effects on the relevant allowable stresses.

Request No. 5:

The licensee should exercise caution in using the test results of Figure 2, Attachment 2 since some of the tests have insufficient data. The licensee should justify the applicability of Berkeley tests to the Indian Point Unit 2 masonry structures.

Response:

A detailed response to this item will be submitted in the final reevaluation report. This response will list the reasons that the test results referred to in the justification of the criteria are applicable to the Indian Point 2 masonry walls. This response will cover both in-plane and out-of-plane loads and will address the applicability of test data and justification for the allowable stresses and the increases for factored loads.

This response will also incorporate the information required to address Request Nos. 7 and 11 that follow.

Request No. 6:

The licensee should provide details for Reference 25 and 26, which are cited but not included in the submitted documents.

Response:

References 25 and 26 are cited in Table 9 of the "Justification of the Criteria" forwarded by Con Edison's February 17, 1981 letter. These references are as follows:

25. Livingston, A.R., Mangotich, E., and Dijkers, R., "Flexural Strength of Hollow Unit Concrete Masonry Walls in the Horizontal Span." Technical Report No. 62 NEMA, 1958.
26. Cox, F.W., and Ennenga, J.L., "Transverse Strength of Concrete Block Walls", Proceedings ACI, Vol. 54, p. 951, 1958.

Request No. 7:

The licensee should justify the proposed 67% increase in gross shear strains for factored loads.

Response:

Our response to this request will be incorporated with our response to Request No. 5.

Request No. 8:

The licensee should justify the proposed 33-1/3% increase in bond stress for factored loads.

Response:

The one-third increase for bond stress is specified in the criteria for reinforced walls. The Indian Point Unit No. 2 walls are not reinforced. The increase in bond stress is therefore not applicable to Indian Point Unit No. 2 and will be deleted from the criteria.

Request No. 9:

The licensee should justify using $E = 1200 f'_m$ instead of the ACI Code value, $E = 1000 f'_m$.

Response:

A number of uncertainties exist in masonry walls with respect to variations in mass, modulus of elasticity and material and section properties. These affect the structural frequencies.

To account for these uncertainties, the criteria for the Indian Point 2 plant require that the modulus of elasticity taken as $1000f'_m$ be varied by plus or minus 20%. The actual value used is selected such as to cause the greatest response of the wall and thus is related to the position of the wall frequency with respect to the peak of the appropriate response spectrum.

If the wall frequency is such that an increase in frequency would cause an increase in the first mode spectrum acceleration, the higher value is used (i.e., 120% of the ACI code value of $1000f'_m$). Conversely, if a lowering of the frequency would cause a higher response, the lower value is used (i.e., 80%of the ACI value).

Response No. 10:

The licensee should justify using allowable stresses applicable to the Special Inspection category and indicate whether quality assurance/quality control information is available to support the categorization.

Response:

Justification for use of allowable stresses applicable to the Special Inspection category will be provided in the final reevaluation report. We are currently investigating whether adequate quality assurance/quality control information is available to support the use of the Special Inspection category allowables.

Request No. 11:

The licensee should explain the applicability of several test results presented in Reference 2 to the masonry structure at Indian Point Unit 2 with specific reference to the type of mortar, the actual boundary conditions, and the dynamic nature of the loading. The following deviations from SEB criteria are observed in the licensee's criteria for allowable stresses applied to factored loads and should be justified by the licensee:

- a. For factored loads, the licensee suggests a 67% increase in allowable stresses for tension parallel to and perpendicular to the bed joint. However, the SEB criteria allow only 50% and 30% increases, respectively.
- b. The licensee suggests a 67 to 70% increase in the allowable shear for both masonry and reinforcement for factored loads. In the corresponding SEB criteria, increases for factored loads are 30% for the masonry and 50% for the reinforcement.

Response:

Our response to this request will be incorporated with our response to Request No. 5.

Request No. 12:

In several instances the licensee has indicated that analysis techniques will be used which are not approved by the staff. The final licensee submittal on masonry walls should consider the following:

- a. The licensee has outlined certain alternative acceptance criteria to be used when the allowable stresses for unreinforced masonry are exceeded. These are based on the "arching theory for masonry walls". The licensee is advised not to use such criteria in the absence of conclusive evidence of their validity as applied to masonry structures.
- b. For walls spanning between two floors, the licensee is advised to use the envelope of the response spectra for the two floors and not their average, as indicated in Section 6.2 of Attachment 1.
- c. It is recommended that the licensee follow Standard Review Plan (SRP) Section 3.7.2 and use a factor of 1.5 times the peak floor acceleration to multiply the weight of the equipment (nonrigid), or provide proper justification if a different factor is used.

Response:

- a. The alternative acceptance criteria based on the "arching theory for masonry walls" will not be employed for evaluation of the masonry walls of Indian Point Unit 2. The option of using the arching theory will be deleted from the criteria.
- b. For walls spanning between two floors, the envelope of the response spectra for the two floors will be used. Stress ratios for all walls will be recalculated using this revised load condition.
- c. All of the masonry wall mounted equipment of Indian Point Unit No. 2 is considered to be rigid. The effect of the equipment on the wall is accounted for by using added mass in the wall models. The requirement to use amplification effects for the equipment will be deleted from the criteria.

Request No. 13:

The licensee should supply the following:

- a. Either the final reevaluation of masonry walls mentioned in reference 2 or a schedule for when it will be submitted.
- b. Information on the method and schedule of any planned modification of masonry walls.

Response:

At the time of receipt of your December 22, 1981 request for additional information, we were in the process of preparing the final reevaluation report. We had planned to submit the report to you in late December, 1981 or January, 1982. As a result of your December 22, 1981 request for additional information, we have decided to defer issuance of the final reevaluation report until the criteria have been modified as described in the previous responses and until the justifications have been developed as you have requested. Some of the justifications will require additional studies to be performed. The revised criteria, the justifications, and information on the methods and schedule will be included in the final reevaluation report. Based on our review of your request, we anticipate that the final reevaluation report will be submitted by the end of June 1982.