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URBANA, ILLINOIS 61801

20 December 1968

Dr. Peter A. Morris, Director
Division of Reactor Licensing
U. S. Atomic Energy Commission
Washington, D.C. 20545

Re: Contract AT(49-5)-2667
Indian Point Nuclear Generating Unit No. 3
Consolidated Edison Company of New York, Inc.
AEC Docket No. 50-286

Dear Dr. Morris:

This will confirm that today I signed the above-referenced report on Indian Point Nuclear Generating Unit No. 3.

Sincerely yours,

W J Hall

W. J. Hall

bjw
cc: N. M. Newmark

APPENDIX H

ADEQUACY OF THE STRUCTURAL CRITERIA FOR

Indian Point Nuclear Generating Unit No. 3

Consolidated Edison Company of New York, Inc.

by

N. M. Newmark, W. J. Hall and A. J. Hendron

INTRODUCTION

This report is concerned with the adequacy of the containment structures and components for the Indian Point Nuclear Generating Unit No. 3 for which application for a construction permit has been made to the U. S. Atomic Energy Commission by the Consolidated Edison Company of New York, Inc. The facility is located on the east bank of the Hudson River at Indian Point, Village of Buchanan, Westchester County, New York; the site is about 24 miles N of the New York City boundary. Indian Point Unit No. 3 will be built adjacent to Indian Point Units 1 and 2.

Specifically this report is concerned with design criteria that determine the ability of the containment system and Class I equipment and piping, as well as Class II structures and equipment, to withstand an Operating Basis Earthquake of 0.10g maximum horizontal ground acceleration acting simultaneously with other loads forming the basis of the design. The facility is also to be designed to withstand a Design Basis Earthquake of 0.15g maximum horizontal ground acceleration to the extent of insuring safe shutdown and containment.

The report is based on information and criteria set forth in the Preliminary Safety Analysis Report (PSAR) and supplements thereto listed at the end of this

report. Also, we have participated in discussions with the applicant and the AEC Regulatory Staff concerning the design of this unit.

DESCRIPTION OF FACILITY

The Indian Point Nuclear Generating Unit No. 3 is described in the PSAR as consisting of a pressurized water reactor nuclear steam supply system designed and furnished by Westinghouse Electric Corporation under a turnkey contract. The plant is to be designed for a power output of 3025 Mwt (965.3 Mwe net).

The reactor containment structure is a reinforced concrete vertical right cylinder with a nearly flat base and a hemispherical dome. The cylinder has an inside diameter of 135 ft. and a wall thickness of 4 ft.-6 in.; the spring-line of the dome begins at a height of 148 ft. above the liner on the bottom of the containment structure. The dome has an inside radius equal to the inside radius of the cylinder, and a thickness of 3 ft.-6 in. The change in thickness at the discontinuity between the cylinder sidewall and the dome occurs on the outer surface of the containment structure.

The inside of the containment structure is provided with a liner which is one-quarter inch thick at the bottom, one-half inch thick in the first three courses of the cylindrical wall except at penetrations where it is three-quarters inch thick, three-eighths inch thick for the remaining portions of the cylindrical wall, and one-half inch thick in the dome. The liner anchorages will consist of one-half inch diameter bent welding studs.

Diagonal shear reinforcing will be employed to resist earthquake shears for the full height of the wall and a distance above the springline into the dome until a point is reached where the dome liner can resist the total shear. The geological description for the site notes that Unit No. 3 will be located on a hard limestone which is jointed, but which provides a solid bed for the plant foundation. The foundation investigation descriptions indicate that the limestone is not cavernous. The report by the consulting geologists contained in Section 1.7 of the PSAR indicates that there are no major geologic faults extending through the site, nor close to it.

SOURCES OF STRESSES IN CONTAINMENT STRUCTURES AND CLASS I COMPONENTS

The reactor containment structure is to be designed for the following loadings and conditions: dead load; live load including snow, ice, construction and equipment loadings); a design accident temperature of about 247°F and a pressure of 47 psig; an internal containment test pressure of 54 psig; a basic design wind loading of 30 psf; tornado loadings associated with a 300 mph tangential wind velocity, a translational velocity of 60 mph, a pressure drop of 3 psi from inside to outside, and associated missiles; and earthquake loading as described next.

The seismic design is to be made for an Operating Basis Earthquake with a maximum horizontal ground acceleration of 0.10g and a Design Basis Earthquake with the maximum horizontal ground acceleration of 0.15g.

The criteria controlling the design of piping and reactor internals for seismic loadings are presented in various places in the PSAR but particularly in Section 15 of Supplement 1.

COMMENTS ON ADEQUACY OF DESIGN

Foundations and Dams

The major facilities structure for Indian Point Unit No. 3 are described as being founded directly on competent bedrock. On the basis of the information presented in the PSAR and supplements, the foundation conditions appear acceptable.

It is noted in Section 11 of Supplement 5 that the possibility of a flood caused by a maximum rainfall coincident with a dam failure will also be investigated. We should like to have the opportunity to examine the results of this study when it becomes available at a later date.

In the course of the construction review of the design of Indian Point No. 2 there was some discussion concerning the increased lateral forces in the transverse direction arising from the action of the crushed-rock backfill against the structure. It was noted that the backfill was not at the same elevation around the entire structure, and thus the lateral force distribution on the structure arising from both dead load and seismic loading are not uniformly distributed circumferentially. Although the crushed rock backfill is mentioned in the Indian Point 3 application, the applicant has advised DRL that backfill will not be placed directly against the Indian Point No. 3 containment wall. It is assumed that adequate clearances will be maintained between the containment wall and any surrounding material.

Seismic Design and Criteria

We are in agreement with the earthquake loading criteria selected for the seismic design, namely that associated with an Operating Basis Earthquake of 0.10g maximum horizontal ground acceleration, and a Design Basis Earthquake of 0.15g maximum horizontal ground acceleration. These earthquake design criteria are in agreement with those given by the U. S. Coast and Geodetic Survey (Ref. 4).

The criteria for the vertical earthquake component are stated in the PSAR to be 0.05g vertically for the Operating Basis Earthquake and 0.10g for the Design Basis Earthquake. We concur in these values for this plant.

We find no discussion in the PSAR concerning the provisions for combining the vertical and horizontal seismic effects with other appropriate loadings, except so far as they appear in the factored load combination expressions. The applicant has informed DRL that it will consider the effects to act simultaneously, and will combine the effects directly and linearly, as appropriate, in accordance with the agreement that was reached in the design of Indian Point Unit No. 2.

The response spectra that are to be used in the analysis are given in Figs. A-1 and A-2 of Vol. 2, and in Figs. 5-7 and 5-8 of Section 5, of the PSAR. These response spectra are for the Operating Basis Earthquake for horizontal and vertical excitation. Spectra have not been presented for the Design Basis Earthquake, but the applicant has advised DRL that the spectra for this earthquake will be scaled upwards appropriately from the Operating Basis spectra. We concur in the spectra to be employed.

The damping values to be used in the seismic analysis are listed at several points in the PSAR and supplements, as for example in the answer to Question 2.7 of Supplement 2, and we concur in the values listed.

The method of dynamic analysis is described in several places in the PSAR, for example in the answer to Question 2.7, but is not described in enough detail to evaluate it completely. It is noted that a modal analysis procedure will be employed and that the total response is computed as the root-mean square sum of the responses of the individual modes. It would be out recommendation that a standard modal analysis procedure be employed which takes account of structural rocking, lateral translation, and shearing, flexural and torsional distortion of the structure, as may be appropriate. With proper attention to the damping and coupling of the various modes, and the procedures by which the various modal forces, displacements, and accelerations are combined, it should be possible to arrive at reasonable and consistent values of stress, shear, moment, etc., to be employed in design.

The design criteria to be employed for Class II structures and equipment were not noted to be explicitly stated in the PSAR and Supplements and it would be our recommendation that critical items falling in this category be designed for approximately one-half of the provisions in the Uniform Building Code for Zone 3.

General Design Criteria

The factored load combinations to be employed in design of the containment structure are given in Section 5.1.2.4 of the PSAR. The loading combinations appear acceptable to us and it is noted that for these load factor combinations

the resistance will correspond to "elastic, tolerable strain behavior." It is also noted that the liner will be designed to assure that the strains in the liner do not exceed the guaranteed yield point at the factored loads, and that sufficient anchorage will be provided to assure elastic stability of the liner. These criteria are acceptable to us.

The applicant has advised DRL that the criteria for handling concrete shear values in the containment vessel will be carried out in line with the discussions that were held in conjunction with the design criteria for Indian Point Unit No. 2, and that the criteria for design of the cranes will be in accordance with those discussed and reported for the Indian Point 2 design.

Liner

The design of the liner receives attention in numerous places in the PSAR and supplements and it appears that the criteria in general are satisfactory. However, in the answer to Question 5.2 of Supplement 2 it is noted that the liner is to be erected true and plumb with certain limitations on deviations, and one of the possible deviations is a 2 inch local buckle. The applicant has advised DRL that this deviation will be limited to a curve over a distance equivalent to one panel. We recommend that this criterion be examined further during the design phase in conjunction with overall ovalling criteria.

Penetrations

The design criteria for penetrations receives attention throughout the PSAR and supplements and especially in the answer to Question 2.11 of Supplement 4. The methods of analysis described and the tentative reinforcing details presented appear acceptable so long as there is assurance of adequate strength and ductility

in the reinforcing ring structure, and in the transition region adjacent to the stiffening ring. It would be our recommendation that a careful measurement and observation program be carried out at the time of the pressure test of the containment vessel to help provide assurance of the adequacy of the design of the large penetrations.

Base Slab

The proposed design of the base slab for the containment structure was reviewed several times in connection with the request for an exemption to permit the construction to proceed at an early date. From the data presented in the PSAR, discussions with the applicant, and our study and evaluation, we believe that the proposed design scheme and criteria can lead to an acceptable base slab design.

Class I Piping, Equipment, Vessels and Reactor Internals

The design criteria for these items are summarized in Section 15 of Supplement 1 of the PSAR and are to be carried out in accordance with criteria presented in Westinghouse Report WCAP-5890, Rev. 1, with modifications as noted in Section 15 of the PSAR. Additional information concerning the stress limit curves to be employed with this design are given in Section 13 of Supplement 5. We are in agreement with the proposed design criteria. The applicant has advised DRL that the criteria just cited supersede the criteria given in Appendix A of Vol. 2, Part B, of the PSAR.

Controls, Instrumentation, Batteries, Etc.

Only general information is noted in the PSAR concerning the seismic design criteria elements of control, instrumentation, batteries, etc. It would be our

recommendation that criteria for these items be examined in detail during the design phases, to insure that the items can withstand the forces, motions, and tilt that might be associated with an earthquake.

Quality Control and Inspection

Quality control, inspection and acceptance procedures are discussed throughout the PSAR and supplements. If properly executed, the procedures outlined appear acceptable to us.

CONCLUDING COMMENTS

On the basis of the information presented in the PSAR and supplements, and in keeping with the design goals of providing serviceable structures and components with a reserve of strength and ductility, we believe that the design outlined for the containment and other Class I structures and equipment and Class II structures and components, can provide an adequate margin of safety for seismic resistance. However, in the report we have offered comments concerning various aspects of design.

W. J. Hall

REFERENCES

1. "Preliminary Safety Analysis Report -- Description of Site and Environment," Consolidated Edison Company of New York, Inc., Indian Point Nuclear Generating Unit No. 3, Exhibit B, Vol. 1, AEC Docket No. 50-286.

2. "Preliminary Safety Analysis Report -- Plant Design Description and Safety Analysis," Consolidated Edison Company of New York, Inc., Indian Point Nuclear Generating Unit No. 3, Exhibit B, Vol. 2, Parts A and B, AEC Docket 50-286.

3. "Preliminary Safety Analysis Report," Consolidated Edison Company of New York, Inc., Indian Point Nuclear Generating Unit No. 3, Supplements 1, 2, 4, 5, AEC Docket No. 50-286.

4. "Report on the Site Seismicity of the Indian Point, New York Area," U. S. Coast and Geodetic Survey, Rockville, Maryland, 20852.