INDEX ITEM NO. 6

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

Docket No. 50-320

SEP 19 1969

Jersey Central Power & Light Company
Madison Avenue at Punch Bowl Road
Morristown, New Jersey 07960

Attention: Mr. John E. Logan
Vice President

Gentlemen:

This refers to your application for a construction permit and facility license for the Oyster Creek Unit 2 Nuclear Power Station. Our preliminary review has indicated that additional information with respect to the quality control and assurance, containment design, and other structural design matters will be necessary to enable us to continue our review.

It is likely that many questions similar to those contained in the enclosed listing have either been addressed in other formal submittals or were previously resolved in connection with other construction permit applications filed with the Commission. This may be true especially with respect to the containment building design. In such cases, we encourage you to respond to these questions by reference to the pertinent documented information, including any additional information needed for clarification or amplification of these matters. Your response on these matters will be necessary to complete the record needed to support your application for a construction permit and facility license.

Sincerely yours,

for Peter A. Morris, Director
Division of Reactor Licensing

Enclosure:
List of Questions

cc: James V. Neely
George F. Trowbridge, Esq.

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JERSEY CENTRAL POWER & LIGHT COMPANY

OYSTER CREEK NUCLEAR STATION - UNIT 2

DOCKET NO. 50-320

1.0 General Structural Design

1.1 Provide a list of Class I items or structures combined with, housed in, adjacent to, or supported by Class II structures.

1.2 Describe the protection to be provided any Class I equipment not in, or supported by, Class I structures.

1.3 State how the earthquake loads will be established for equipment in 1.2 above.

1.4 Describe the design methods used for the combined structures in 1.1 above.

1.5 Justify a combined rotational and translational tornado wind velocity of 300 mph.

1.6 Describe the spectrum of external missiles which the facility will be protected against above 25' from ground and how this protection will be provided.

1.7 Describe the design criteria and bases for the supports for the major components in the reactor coolant and emergency cooling system, including in particular the reactor vessel, steam generators, pressurizer, main coolant pumps, and safety injection tanks.

1.8 Describe the protection against, and effects of, a tornado on the fuel pool.

2.0 Containment Structural Design

2.1 For the containment structure, provide:

(a) Scaled load plots for moment, shear, deflection, longitudinal force, and hoop tension, in order that an appraisal can be made of the significance c the various loadings which influence the containment design. Provide these plots for several containment heights for the following loadings: prestress, dead, pressure, design earthquake, wind, liner thermal (normal and accident) and concrete thermal (normal and accident).

(b) The normal operating and transient accident thermal gradients to be used in the design of the containment for the typical winter and summer days.

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(c) A description of torsional loads and how they will be handled.

(d) The values of $E_c$ and $u_c$ for cracked and uncracked reinforced concrete structure for different elevations and explain their use in the design of the concrete shell and in thermal liner loading computations. Include the effect of shrinkage and creep. State whether the computer program to be used takes into account these variations of $E_c$ and $u_c$, and also axisymmetric loads.

(e) The analytical procedures used for arriving at the forces, shears, and moments in the structural shell, considering that the structure is not axisymmetric (buttresses).

(f) The considerations given to, and the analytical procedures used for determining discontinuity stresses at the base, dome (ring girder), and buttresses. State the assumptions, with regard to structural stiffness, that form the basis for these stress determinations and indicate the extent to which variations of $E_c$ and $u_c$ are considered.

(g) Because of cracking of concrete due to shrinkage, to testing, to thermal stresses, and during an accident, the problem of adequate bar anchorage is of special concern. Provide information on how the reinforcing bars are anchored at certain critical points such as: center of the dome, intermediate terminal points of radial bars in the dome, bars provided to take discontinuity stresses, some diagonal bars, bars connecting the buttresses to main shell, bars under prestressing anchors, etc.

(h) Discuss the influence of cracking on bond and anchorage of bars terminating in a cracked zone. The increase of crack width during the life of the plant due to thermal cycling, to progressive shrinking and creep of concrete, to weathering (freezing and thawing), to seismic loading occurring during the life of the plant, and to stress reversal, should be considered.

2.2 Indicate whether the following have been or will be considered:

(a) Possible reversal of stresses due to creep during cold shutdown.

(b) The cracking of the cylindrical wall, compared with the behavior of the uncracked mat.

2.3 For the base slab, describe:

(a) The analytical procedures used to arrive at the forces, moments, and shears, considering the non-symmetric loading and deformations of the mat. State whether transient thermal gradients have been considered.

(b) The elastic properties of the sands which have been used for the design.

2.4 With respect to seismic design of the containment, describe:

(a) The general analytical model for the containment including mass distribution, stiffness coefficients, modes of vibration, and analytical procedures for arriving at a loading distribution on the containment structure.

(b) The manner in which damping will be considered in the structural design. Justify the damping values employed for the various components of the structure considering possible cracking and different modes.

(c) The extent and manner in which the horizontal, vertical and rocking motions will be considered in the design, and how the corresponding damping will be included. Describe the motion of the structure with respect to ground using the above three components of action.

2.5 With respect to liner design, describe:

(a) Types and combinations of loading considered with regard to liner buckling, and the safety factors provided. Include the influence of large tangential strains due to possible opening and closing of cracks in the concrete under the load combination that includes accident and earthquake loads.

(b) The effect on the liner plate of sudden cooling by the containment sprays.

(c) Tolerances on liner plate thickness and liner yield strength variation and the bases for the selected values.

(d) The possibility of elastic and inelastic buckling especially at base of the wall. Provide sample calculations showing the influence of all pertinent parameters, such as:

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Variation of plate thickness;
Variation of yield point of liner steel;
Influence of Poisson's ratio for steel;
Erection inaccuracies (local bulges, offsets at seams, wrong anchor location);
Prestressing;
Creep of concrete;
Variation of Young's modulus and Poisson's ratio for cracked and uncracked concrete, and as a function of stress level in concrete (elastic and plastic); and
Ground water infiltration, earthquake, temperature loading.

(e) The stress and strain limits used for the liner, the bases for these limits, and the extent to which these limits relate to liner leakage.

(f) If the effect of temperature rise in the liner will be represented by a uniform pressure increase, justify this approach.

(g) Describe the design approach that will be used where loadings must be transferred through the liner such as at crane brackets or machinery equipment mounts.

(h) It is noted that the bottom liner is not accessible for inspection during the life of the plant. It is therefore very important to avoid any unnecessary stresses and strains in the bottom liner. The arrangement for load transfer through liner under the bottom of the interior structure should provide for transfer of shears parallel to the liner. Indicate how the shears, especially those due to thermal expansion and earthquake, will be accommodated.

(i) Describe the liner arrangement to be used at the base-cylinder to liner juncture, the strain limits imposed at the juncture, and provide an analysis of the capability of the chosen liner arrangement to absorb these strains under design basis accident and earthquake conditions. Discuss the influence of local cracking on liner anchors.

2.6 For the design of the liner anchorages, describe:

(a) The analytical procedures and techniques to be used, including sample calculations.

(b) The failure mode and failure propagation characteristics of anchorages. Discuss the extent to which these characteristics influence leaktightness integrity. Indicate what design provisions will be incorporated to prevent anchorage failures from jeopardizing leaktight integrity.

(c) How elastic and inelastic buckling of the liner will be considered in the design of the anchors. Discuss the possibility of unbalanced loads acting on one or several anchors and provide a study showing that no chain reaction can occur and that massive buckling of the liner, and mass failure of anchors is excluded.

2.7 With regard to penetration design, describe:

(a) The design criteria that will be applied to ensure that, under postulated design basis accident conditions potential resultant torsional, axial, bending, or shear piping loads will not cause a breach of the containment. Include the design criteria intended to prohibit pipe rupture between the penetration and containment isolation valves. Specify the codes that will be used. Provide design details for typical penetrations to illustrate how the criteria will be applied.

(b) The extent to which the penetrations and the applicable surrounding liner regions will be subjected to vibratory loading from equipment attached to the piping systems. Indicate how these loads will be treated in design.

(c) Criteria for concrete thermal protection at penetrations; include the temperature rise to be permitted in the concrete under operating conditions and the time dependent effect that loss of thermal protection would have on the containment's structural and leaktightness characteristics. Indicate the thermal gradients that will be used for design purposes.

(d) The capability of the penetration design to absorb liner strain without severe distress at the opening.

(e) The manner in which axial stresses, loop stresses, shear stresses, bending stresses (in two directions) and shear stresses due to torsion will be combined in the plastic domain, if the full plastic strength of a pipe with regard to torsion, bending and shear is to be used. State the failure criterion to be used. Indicate how the exterior loads including jet forces will be combined. Give factored loading combinations for all the loads for all types of penetrations considered in the design. Explain how the Standard Code for Pressure Piping-Power Piping, B31.1.0-1967 will be used for these loading cases. Indicate whether factored load combinations will be used with this code.

(f) For all penetrations, the criteria that will be used for the bending of reinforcing bars which have to clear the opening. Criteria defining maximum slopes and minimum bending radii to avoid local crushing of concrete should be included.

(g) For penetrations between approximately 9 inches and 4 feet in diameter, how normal, shear, bending, and torsional stresses will be covered by the prestressing and the reinforcing bars.

2.8 For large openings describe:

(a) Criteria with regard to opening sizes that constitute large openings; hence, meriting special design consideration. List the number and indicate the size of the large openings for the containment.

(b) The primary, secondary and thermal loads that will be considered in design of the openings.

(c) The stress analysis procedures that will be used in design.

(d) The method that will be followed for the design (working stress design method. ultimate strength design method, or both). If ultimate strength is used, the factored load combinations should be given together with corresponding capacity reduction factors.

(e) How the existence of biaxial tension in concrete (cracking) will be taken care of in the design and how the normal and shear stresses due to prestressing, axial load, two-directional bending, two-directional shear, and torsion will be combined. Also, state the proposed criteria for the design of the thickened part of the wall around the opening (ring girder).

(f) The method to check the design of the thickened stiff part of the shell around large openings and its effect on the shell. Include the manner of considering prestressing, creep and shrinkage. Comparison with stresses in a circular flat plate would not be convincing, since it eliminates the effect of torsion which is one of the most important effects involved. How will torsional stresses be checked?

(g) Additional information on reinforcing patterns and prestressing patterns that will be used around large openings (i.e., rebar size and spacing).

(h) The safety factor provided in design at large openings. Sample computations should be provided, listing all the criteria and analyzing the effect of all pertinent factors such as prestressing, cracking, etc.

2.9 For the design of the tendon anchorage zones,

(a) Provide a description of the procedures used for analyzing anchorage zones and provide typical results of such analyses. Include consideration of biaxial tension in concrete.

(b) Provide typical details of anchorage zone reinforcing. Provide information to support the acceptability of this method to resist the imposed anchorage loading (particularly under long-term loading). Justify bond values used for anchorage of reinforcing bars.

2.10 Provide an evaluation of the corrosion inhibiting characteristics of the grouted tendon prestressing system. Clearly identify all supporting evidence and include discussions of the following:

(a) Use of, and reports from, specialized consultants on the corrosion potentials and protection requirements.

(b) Grout composition and interaction with the tendons. Specifically, include effects of hydrogen or nitrogen generated by the grout and admixtures. Discuss the resulting possibility of embrittlement.

2.11 Provide discussions on the following:

(a) The extent to which the structure will, because of the use of grouted tendons, behave as a brittle structure in relation to an unbonded design, which is relatively insensitive to local cracking.

(b) With respect to the long-term surveillance program for the tendons, list the methods to be used, the surveillance intervals, the acceptance criteria, and steps to be taken if the acceptance criteria are not met in any instance.

(c) State the value of the bond stress transfer between the tendon conduit and the contracting internal and external concrete surfaces. State whether the crack control/temperature reinforcing and tendon anchorages will be designed taking credit for this bond or whether it will be designed similar to that for an unbonded tendon system.

(d) The maximum allowable percentage of void area in the grouted cross-section within the prestressing conduit and the basis for this value.

(e) State whether the design accommodates the secondary stresses which the tendon will experience due to discontinuities of the shell, dynamic loads, temperature, bending, etc.

(f) Provide the sequence of prestressing and grouting.

3.0 <u>Materials</u>

3.1 Describe the type and usage of admixtures, their compliance with ASTM specifications, and extent of testing.

3.2 Provide the detailed material selections for containment penetrations, list the corresponding ASTM specifications and indicate NDTT considerations in their selection.

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4.0 Construction

4.1 Supplement the listing of codes with an additional list of any documents (U.S. Army Corps of Engineers, Bureau of Reclamation, etc.) which may be used as the basis for your specifications to contractors to cover items not recognized by specific codes. State the basis on which these supplementary mandatory specifications will be prepared.

4.2 Since ASME Standards do not define erection tolerances in sufficient detail to ensure a satisfactory erection of the liner (e.g., they do not cover local curvature deviations), provide the comprehensive set of erection tolerance standards selected for the liner, and show that they identify and satisfactorily limit all inaccuracies likely to occur during erection.

4.3 Give a detailed description of the placing of concrete in the dome, especially near the center portion of the dome.

4.4 Indicate the extent to which splicing of reinforcing steel will be made by welding. State the location of these welds.

4.5 Describe the "splicing" of inclined bars, or horizontal stirrups provided to take the radial shears in the base of the walls, with the vertical bars. If done by lapping the diagonal bar with a vertical bar or by bending the stirrup around a vertical bar demonstrate that, despite bi-axial tensile stresses in concrete and vertical and horizontal crack patterns, the load in the diagonal bars or stirrups can be transmitted safely to the vertical bars.

4.6 Specify the proposed quality control procedures for the strength welds of reinforcing bars to structural elements such as plates, rings, and sleeves.

4.7 Describe the compositional specifications for reinforcing bars which are to be welded, and what degree of non-destructive testing (x-ray, dye penetrant test, etc.) will be performed.

4.8 Indicate the extent of user verification testing of certified liner NDTT properties, liner thickness, ductility, weldability, etc.

4.9 Describe those quality control procedures and standards for field welding of liner plate that differ from the general procedures and standards. Include welder qualifications, welding procedures, post-weld heat treatment, visual inspection, magnetic particle inspection, liquid penetrant inspection and construction records.

4.10 Indicate the requirements that will be placed on seam welds to assure adequate ductility.

4.11 Indicate the factory quality control requirements that will be imposed on the prestressing system to insure that production material will meet design requirements and specifications.

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4.12 Describe the corrosion protection that will be given to the prestressing wire or strand at the factory, through transportation, and in the structure prior to prestressing.

4.13 Indicate the scope and extent of quality control testing of anchorage components and production anchorage assemblies.

4.14 If the sister splice technique is used for testing Cadweld splices, state how many backup production splices will also be tested.

4.15 Give the testing procedure to be followed if a test splice turns out to be unacceptable.

5.0 Testing & Surveillance

5.1 Provide a table that compares the computed stresses for two different pressure test conditions with the computed stresses due to the design basis accident alone, and to the earthquake plus accident conditions. The information should be sufficient to evaluate the reliability of the stress computations. Explain the methods used in the preparation of this table, the physical constants employed, etc. Include the following:

(a) Thermal stresses at large openings: evaluation of temperature gradients, stress computations for concrete and reinforcing steel, methods of combining stresses due to normal, tangential, bending, and torsional load, assumptions on cracking, stresses in stirrups, etc.

(b) Prestressing.

(c) Influence of shrinkage.

(d) Creep.

(e) Influence of liner elastic and plastic deformations.

(f) Liner stresses before cracking of concrete occurs.

(g) Influence of transient thermal gradients.

5.2 Provide an analysis of crack size, spacing, and pattern expected during containment structural testing.

5.3 Describe the surveillance capabilities provided by the containment design with reference to both periodic inspection of the prestressing system and the steel liner and periodic structural testing of the containment. If the leak rate testing is intended to be performed at reduced pressure, provide an evaluation of the minimum level of such tests that would also serve to verify continued structural integrity. Consider in the evaluation structural response and surveillance instrumentation requirements. Indicate what provisions will be made for individual testing of selected tendons.

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6.0 SEISMIC DESIGN

Appendix 5A (page 5A-5) states the design criteria for Class I systems and components, and refers to a method of analysis described in the Florida Power Corporation's PSAR for Crystal River Unit 3, Docket No. 50-302, Amendment No. 2 (Supplement No. 1) dated February 7, 1968, Question 9.11. To clarify the proposed design criteria, confirm that all Class I systems and components will be designed using the loading combinations and stress limits listed in page 9.11-5 (Revised 4-8-68) of the Crystal River Unit 3 application. Also, compare the proposed design criteria with the criteria for emergency and fault conditions recently approved by the ASME Section III Committee.

Provide strain limits for the principal materials of construction for the loading combination including simultaneous maximum earthquake and loss-of-coolant loads.

Describe methods that will be used for seismic analysis of Class I systems and components. As an example, describe the analytical model to be used for the reactor coolant system, including location of lumped masses and support conditions.

Identify specific reactor internals which must maintain their functional performance capabilities to assure safe shutdown of the reactor. Provide calculated (or estimated) maximum limits of deformation or stress, at which inability to function occurs, for each component identified. Also, supply the calculated (or estimated) maximum design limit value, and the expected deformation or stress. In all cases identify the applicable loading combination and state the proposed margin of safety.

For reactor internals provide information that will permit evaluation of the effect of irradiation on the material properties and on the proposed deformation limits.

7.0. THERMAL SHOCK ON REACTOR COMPONENTS

With regard to thermal shock on reactor components, induced by operation of the emergency core cooling system (ECCS), the PSAR (page 4-18) refers to the results reported in Metropolitan Edison Company's PSAR for Three-Mile Island Nuclear Station (Docket No. 50-289), Amendment No. 3 (Supplement No. 2), dated November 6, 1967, Question 11. Provide details of the brittle fracture analysis, including equations used to correlate crack size with the calculated stress intensity factor ($K_I$), and update results of the analysis.

8.0 QUALITY ASSURANCE MATTERS

8.1 Provide a general discussion of the experience accumulated by the Jersey Central Power & Light Company in the general areas of quality assurance and control. Include references, if applicable, to experiences with large conventional plants owned by the Company, and the organization, staffing, and experience of any permanent in-house groups responsible for quality.

8.2 Provide a functional organization chart for Jersey Central Power & Light Company detailed to show responsibility channels for Quality Assurance (design) and Quality Control (inspection) efforts, including consultant services enlisted.

8.3 Provide a functional organization chart for Burns & Roe, Inc., and describe the responsibility channels for Quality Assurance (design) and Quality Control (inspection) efforts, including safety related electrical, instrumentation and control systems. Include the site organization, consultants and service organizations which have been enlisted.

8.4 Will electroslag welding be used for any Class I pressure vessel, and if so what is the applicant's planning for quality control requirements during fabrication?

9.0 INSTRUMENTATION & CONTROL

9.1 Please perform a fault analysis of the relay contact matrices which directly control the scram breakers. This analysis should include considerations of fault detectability by the proposed testing methods.

9.2 Please describe the qualification tests which will be performed on vital instrumentation and control equipment (including wiring) located within containment.

9.3 Our review indicates that single failures of individual pump monitors were not considered in analyses of flow loss transients terminated by monitor action. Please analyze all such transients assuming that one monitor fails to indicate the loss of its respective pump.

9.4 Please describe the control system which initiates runback in the event of asymmetric rod patterns. What are the consequences of failure to provide runback when required? Can any failure cause the system to withdraw rods?

9.5 Please analyze the consequences of withdrawing rod groups out of sequence.

9.6 Please describe your criteria for cable tray loading, and cable derating, routing and overload protection. This question is intended to explore the immunity of your design to catastrophic cable fires.

9.7 Are the circuits which tie together the engineered safety feature busses controlled manually or automatically?

9.8 With respect to redundancy and independence, what are the design criteria for the d.c. circuits which control the load-shedding and load-connecting breakers in the engineered safety feature busses?

9.9 Are your station batteries located in separate rooms in a Class I structure?

9.10 Please evaluate the stability of the external power network. What is the effect upon the network of tripping one unit? What is the effect of simultaneously tripping both units?

9.11 What are your criteria with respect to diesel generator loading margins?

9.12 Please describe the quality control procedures which apply to the equipment in the reactor protection system, emergency safety feature and containment isolation systems, and the associated emergency power systems. This description should include, but not necessarily be limited to, (a) quality control procedures used during equipment fabrication, shipment, field storage, field installation, and system component checkout; and (b) records pertaining to (a) above.

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10.0 GENERAL SEISMIC DESIGN

10.1 Indicate the various foundation levels with regard to existing grade, finished grade, and the underlying soil strata. Also provide a discussion of the potential for liquefaction under the various structural foundation.

10.2 For the containment seismic design, as well as Class I equipment and items such as piping, describe the methods for computing mode shapes, frequencies and participation factors, and the methods for combining the modal values to obtain the design values of acceleration, shear, moment, etc.

10.3 If seismic coefficients are to be used for design in place of normal modal analysis procedures, explain the basis for selection of the coefficients and their application.

10.4 State whether earthquake stresses will be added linearly and directly to the other applicable stresses.

10.5 Under the factored load design, will the load capacity be limited to yield or below? If the total stress exceeds yield, describe the criteria employed to ensure that stresses and deformations are limited.

10.6 Provide loading combinations for which the piping is to be designed and the stress and strain criteria applied for earthquake loadings.

10.7 For the prestressing tendons, give strand details, showing the number of strands per tendon. Also provide approximate dimensions and spacings of anchorage zones both through the wall thickness and along the circumference of the structure.

10.8 Describe functionally the side gallery (not the prestressing gallery) located above the foundation slab to about grade.

10.9 Describe design criteria which ensure that critical controls, instrumentation, batteries, etc. will operate properly to provide safe shutdown under seismic or other design loads.

10.10 Give the design criteria for design of the cooling water intake structures and associated piping critical to the safe shutdown of the plant under seismic, hurricane or high water conditions.

10.11 Consistency of design with the 0.22g earthquake would indicate that Class II structures and equipment be designed to 2/3 of the Uniform Building Code Zone 3 requirements. Indicate the design criteria and details for Class II structures and components.

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