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

FORMAL DOCKET COPY

IN REPLY REFER TO:
Docket No. 50-261

OCT 28 1966

Carolina Power and Light Company
336 Fayetteville Street
Raleigh, North Carolina

Attention: Mr. P. S. Colby
Vice President

Gentlemen:

This refers to your application dated July 12, 1966, for a construction permit and operating license which would authorize construction and operation of a nuclear power reactor, designated H. B. Robinson Unit No. II, located in Darlington County, South Carolina.

As you know, a meeting was held on September 2, 1966, with representatives of your company and the Regulatory Staff to discuss your proposed containment design. In this meeting, you indicated that the containment design had been modified. These modifications were included in Supplement No. I to your application dated October 10, 1966. Based on our review of Supplement No. I, we have concluded that additional information concerning the containment is required.

Also, a meeting was held on September 20-21, 1966, to discuss all other areasof the design. During this meeting, you indicated that several design changes will be made in the engineered safeguards system. As a result of these design changes, our review of the application, and discussions with you, we have determined that additional information concerning the topics of discussion at this meeting is necessary to complete our review. Accordingly, you are requested to provide the information listed in the enclosure.

In order to facilitate our technical review, we urge that you place particular emphasis on providing full and complete answers to each of the attached questions so that further questions covering the same material will not be required. The staff, of course, will be available as may be required to discuss and amplify the meaning of the questions.

Your reply to these questions should be submitted as an amendment to your application.

Sincerely yours,

Peter A. Morris

Peter A. Morris, Director
Division of Reactor Licensing

Enclosure:
As stated above

CAROLINA POWER AND LIGHT COMPANY - ADDITIONAL INFORMATION REQUESTED

I. Questions Concerning the Site

A. Describe the scope of the pre-operational environmental monitoring program, particularly with reference to the natural activity of the water, fish, and lake bottom.

B. We note that a considerable portion of Lake Robinson is located within the exclusion distance, and that the immediate vicinity of the plant and the water intakes are accessible to the public. In view of this, discuss the hazards this could involve during both normal and emergency operations. What type of control will be implemented to protect the public in these areas?

C. Discuss the type of emergency arrangements which will be made to protect the residents who live in the immediate vicinity (less than one mile) of the plant.

D. Discuss the population of Florence and its contiguous metropolitan area to show why it should not be considered as the nearest population center of 25,000 or more, rather than Columbia.

II. Questions Concerning the Novel Features of the Plant

A. Control

(1) Please describe the control room layout and locate the control boards for each plant. Discuss your reasons for not locating each board in a separate room. In this discussion, consider possible interaction of alarms and operator function under normal and abnormal conditions for these two different type plants.

(2) Describe the location and function of the waste disposal control board. What indications relating to the release of contaminated wastes are on this board and on the main control board?

(3) Indicate which personnel associated with reactor operation will be at the site during off-hours in addition to the Shift Foreman, the Control Operator, and the Auxiliary Operator listed in Section 13.1. Indicate which will have operator licenses, and for those not licensed which will have knowledge of the equipment in the nuclear facility. Discuss the adequacy of the Shift Complement to properly respond to and/or correct the more demanding types of credible accidents associated with the reactor. Relate to post-accident requirements for operation of manual valves, observations, and other duties.

B. Automatic Load Dispatch

(1) Provide a diagram of all components from the computer to the turbine throttle valve. What interlocks or operator actions will automatically defeat the system? What is the approximate frequency of demand signal and average amount of change requested per demand? Discuss failure modes and redundancy of all circuits including that of rate limiting equipment. Are power demands continuously recorded?

(2) Describe the function of each component in the automatic load dispatch system proposed.

(3) Indicate how the Control Operator becomes aware that the automatic dispatch system has signaled for a change in reactor power. Does the Control Operator know the new demand setting on the reactor control circuit? Indicate the minimum amount and rate of power change which would be indicated to the operator.

(4) Have you given consideration to requiring the operator to acknowledge the computer's request before a new power setting is made by the automatic dispatch system? Please discuss your reasoning in this regard.

(5) How would the operator distinguish between rod withdrawal demanded by this system versus an uncontrolled rod withdrawal?

C. Net Load Rejection

(1) Describe the equipment provided in the steam system which provides capability to safely maintain the reactor at critical after a net load rejection.

(2) Provide plots of valve position, steam generator pressure and water level, pounds of steam dumped to the atmosphere and the condenser, primary temperature and pressure, core reactivity (for both positive and negative moderator coefficients) and power level, primary coolant flow rate, control rod position, and turbine speed as a function of time after a net load rejection. These plots may be discontinued when the plant is in stable operation at auxiliary power.

(3) Discuss the automatic action which will take place to protect the the core, turbine and steam system if the control valves fail to operate as assumed.

(4) Discuss the changes made in the control rod drive speed and delta-T programmer to accommodate this feature. How are the criteria on rod worth limits affected during load rejection?

(5) Describe and diagram the control circuits which signal for operation of the additional valves in the steam system. Indicate what information from sensors in the primary and secondary system will be used for controlling these valves. Will there be separability of control and safety function?

(6) Is any rapid change in boron concentration required?

(7) Discuss proof tests from 100% power which are planned to demonstrate proper operability of the system.

III. Plant Layout

A. Please provide an updated drawing and discussion of the overall plant layout. The following information should be included.

(1) The location of all Class I equipment and buildings. Where Class I equipment is located in other than a Class I structure, describe how a foundation and protection equivalent to Class I will be provided. Discuss the potential damage (under the 0.2g earthquake loadings) which could occur at these locations and describe how protection is provided. What alternate equipment is provided to back up this Class I equipment for the applicable postulated accidents?

(2) The general location of all piping penetrations and piping runs external to the containment. For those associated with the engineered safeguards, show the external piping and valve locations. Include location of, and criteria for, necessary missile shielding.

(3) For areas in the auxiliary building where access to the recirculation loops of the safety injection system is required, state the criteria for the location of radiation shielding which will enable the operator to perform the required duty. What is the dose criteria at these locations during the "100% core melt" MCA?

B. Please discuss the consequences of a turbine-generator failure in which missiles are generated. Referring to the drawing provided in "A" above, present an analysis of the ability of all critical structures and components including the control room to maintain the "no loss of function" criteria if they are in a potential trajectory of such missiles.

C. We note that Class I structures (excluding containment) are designed using a critical damping of 5.0 percent. Discuss the criteria for placement of reinforcing steel or mesh steel in all Class I structures (other than containment) to assure that cracking of concrete will not result in large pieces falling during an earthquake.

D. For all Class I equipment other than containment, state your criteria in terms of % yield stress or % yield strain to assure no loss of function under 0.2g earthquake loadings. For areas of local high stress concentrations, indicate if code rules are followed.

E. Discuss the ability of all Class I structures and safeguards located external to Class I structures to withstand, without loss of function, missiles generated by hurricanes or tornadoes. What size and velocity criteria are used?

F. We understand that the control room is located above the diesel generator and switch gear rooms. If a fire were to occur in either location, discuss the protection available to allow operating personnel to remain in the control room and also to protect vital control systems. Where is the wiring which leads to the control systems located?

G. Discuss the fabrication inspection and quality control techniques, as well as the organizations and their responsibility for inspection and quality control, which will be used in plant field fabrication of Class I items excluding containment. Provide information to establish the degree of independence of the inspection and quality control organizations from production and schedular pressures.

H. Where is the liner placed in relation to the concrete in the main sump?

I. Only one vertical section drawing of the containment internals appears in the application. Please provide similar drawings to locate all of the principal system components and shielding.

IV. <u>Instrumentation and Control</u>

A. Discuss the redundancy criteria for the instrumentation, relays, wiring, etc., to be provided for the circuitry of the remotely operable components in the safeguards system (including valves). Discuss whether a single short will disable the control circuits.

B. State your criteria for providing instruments to indicate the reactivity status of the reactor; and the pressure, temperature, water levels, and activity inside the containment after the MCA. Discuss the design lifetime criteria of the critical components associated with this equipment when operated in the post-MCA containment environment.

C. Describe the location, type of detector and circuitry associated with the containment pressure monitoring system. Will a continuous recording of containment pressure be made? If this is considered to be unnecessary, discuss your reasoning.

D. Discuss the provisions incorporated in the design to prevent control room fire. Analyze the consequences of the control room becoming uninhabitable or ineffective due to a fire (or other disaster) in the control room. This analysis should also include consideration of the availability of engineered safeguards systems' power and controls. Will alternate control areas for operation of emergency equipment be furnished?

E. What assurances are there that faults created within wiring as a consequence of being located in the post-accident environment should not be reflected into essential safeguards circuits external to containment?

F. Please list those instrument channels which provide both safety (scram) and control functions. Can a single failure which initiates a control malfunction simultaneously remove the redundancy of those safety channels designed to terminate such a malfunction? If so please justify your design.

G. There are several lines which penetrate containment and which would be expected to be open to containment atmosphere subsequent to MCA. Lines connected to the primary system, lines normally open to containment atmosphere, certain unprotected lines, etc., are examples. Has consideration been given to providing double, independent, automatic isolation valves on such lines that also terminate in open (uncontained) systems external to containment? Please justify your answer. Will the containment isolation valves automatically re-open (subsequent to an accident) when the initiating parameter (radiation, high pressure, etc.) returns to a low value at the sensor; or is a positive re-setting action required?

H. Rod position indication as measured by the "electrical coil stacks" (LVDT's) will be read out on a recorder on a (group) selected basis. Since all rod positions will not be indicated simultaneously, discuss why a stuck rod would not go unnoticed.

I. A two-pen recorder is provided to record and indicate two log or linear flux channels in terms of complete coverage (with variable gain) or in steps of two decades. In our opinion, this can be confusing. Discuss the consideration that has been given to providing a separate recorder for the linear flux channels.

J. In the event of a loss-of-coolant accident and simultaneous loss of outside power, a complicated automatic sequencing action takes place to start the diesel generators and connect essential loads. This action is accomplished by a control system which must sense failure of a diesel to start, and/or a faulted bus, and/or the failure of a particular safeguard to start and to take appropriate steps to connect the alternate safeguard. Discuss the reliability of this control system in terms of redundancy and fail safety. Can a single failure nullify its operability? Is there manual override even when the control system acts to take inappropriate action (not merely a passive failure)? What type of pre-operational and periodic tests are planned?

K. Do the linear variable differential transformers used for rod position indication require forced air cooling? If so, what effect can loss of cooling have on position indication accuracy?

L. How soon after a total loss of control room ventilation (including air conditioning and forced air cooling at the instrument cabinets) would the reactor instrumentation signals be degraded below acceptable accuracies?

M. Please analyze the method of detection and effects of loss of forced air cooling at the ion chambers.

N. Describe the operation of the main coolant pumps after primary system pipe breaks of different sizes. Describe the circuits which signal for such operation. What are the consequences to the main coolant pumps and motors if the instrumentation fails to operate as designed?

V. Plant Systems

A. Missile Protection Inside Containment

(1) It is not stated in your application that protection will be provided for missiles generated from failure of a main coolant pump. Please discuss the ability of the primary and secondary system to remain intact upon failure of the impeller, fly-wheel or rotor of a main coolant pump. Also, discuss the ability of the missile shielding to preclude such missiles from damaging the containment liner or safeguards systems.

(2) On pages 1-42, it is stated that the pressurizer is completely enclosed in concrete. Would this concrete provide sufficient missile shielding to withstand missiles generated from massive failure of the pressurizer?

B. Provide a drawing of the control rod housing arrangement on the vessel head. Discuss in detail the possibility that a rod ejection due to control rod drive thimble failure (either a circumferential or vertical failure) could lead to failure of other adjacent thimbles. Consider the effect of the thimble hitting the missile shield above the rod housings and being deflected causing failure of adjacent thimbles.

C. Primary System Components

(1) Please provide the following information concerning the design adequacy of systems in the primary system. Each answer should include the requested information as it applies to the: (a) reactor vessel, (b) steam generators, (c) primary piping and pump casings, and (d) pressurizer.

(a) List the code vessel classification selected for each component.

(b) We understand that a number of steps are specified in the design, quality control, and fabrication of these components above and beyond the requirements of the applicable ASME and ASA codes. Please provide a list of these specifications which improve the quality and provide a greater safety margin for each component.

(c) Discuss the provisions incorporated in the design to detect and locate the source of leakage from each of these components during operation. State the criteria for corrective action.

(d) Discuss the inspection and fabrication techniques used in field pipe welding to assure that the design criteria are met.

(e) Describe the provisions to allow for in-service inspection of inner and outer surfaces of this equipment. Indicate the test method to be used (i.e., UT, dye penetrant, etc.) for each area and discuss the ability to detect significant weaknesses in the material. Do the areas which will be inspectable correspond to those areas where the location of crack development is most likely to occur for each type of structure?

(f) State your criteria in terms of stresses or deflections for the combined hypothetical earthquake and accident loadings. This should include internal pressures along with seismic forces, blowdown reaction forces, rapid thermal variations, etc.

(2) In relation to the pressure vessel and reactor internals, provide the following:

(a) Details of the surveillance program indicating location of sample capsules and number and type of samples. What is the expected integrated fast neutron flux at the vessel wall?

(b) State the magnitude of forces on thereactor vessel internals during blowdown accidents resulting from hot line or cold line breaks, and discuss the ability of these components to withstand such forces.

(c) Indicate the type of insulation to be used on the outer surface of the vessel and state the clearance between vessel and insulation. Is this material designed to allow for water flow in contact with the vessel after an MCA? Is sufficient space provided to permit UT or other methods of inspection?

(d) Provide the results and method of analysis which show that the reactor pressure vessel is designed to accommodate without failure the transient loading, at the end of its fatigue life, due to safety injection of cold water up to the level of the main coolant nozzles. Assume maximum deluge rate starting from an empty vessel. State your failure criterion. State the initial vessel temperature used in the calculations. Also, estimate the limit of the initial vessel temperature which could cause vessel failure upon injection. Relate this temperature to the maximum delayed injection time before vessel wall temperature could reach the limit.

(3) Regarding the design of the steam generators and feedwater system discuss the following:

(a) It is stated that the tube sheets will remain within 90% of yield in the event of a steam line rupture accident. Discuss whether a hydrostatic test conducted at 100°F and 3110 psi will simulate the load conditions which would apply stresses equivalent to 90% of yield at 650°F and pressure equivalent to the primary system safety valve setting. Is an ample margin to failure assured by the 90% yield criteria? Discuss the appropriateness of your design limits relating to Section III requirements.

(b) Provide the design criteria in terms of steam generator water level as a function of time for the emergency feedwater turbine pump. Describe the automatic and manual action required (1) assuming a loss of off-site power, and (2) assuming simultaneous steam line rupture and loss of off-site power.

D. Plant Ventilation

(1) Please provide a diagram of the following ventilation systems. Locate all inter-connections, valves, fans, and filters.

(a) Condenser air ejector to the plant vent.

(b) Turbine building ventilation system.

(c) Containment purge and ventilation systems.

(d) Primary auxiliary ventilation system.

(e) Control room ventilation system.

(2) Describe the system to be used for post-accident ventilation of the control room. Discuss the type of filters, flow rates, and other assumptions used in determining the thyroid dose in the control room. Plot the thyroid dose as a function of time after the MCA received during egress from the control room to areas outside containment and in areas inside the auxiliary building assuming fission product source from 100% core melt. How will restricted egress affect the ability to manually operate safeguards equipment and isolation valves. What assumptions are made for iodine concentration in the auxiliary building.

(3) Describe the valve type, arrangement, and control circuit to be used to maintain the containment pressure below 0.3 psig. Is this an automatic control system? Is it disabled upon isolation?

E. To facilitate our evaluation of your penetration isolation system, please provide the following information in detail.

(1) State your criteria in terms of leakage through both electrical and piping penetrations. What tests and equipment will be used to verify this rate? What is the accuracy of this method?

(2) We understand that a different isolation valve seal water system will be provided than that described in your application. Please describe the new system anddiscuss its operation. How is this system periodically tested to assure injection flow into all lines provided with the injection system? Can the system be tested for injection flow during reactor operation?

(3) Provide a list in which the following information is presented for all piping penetrations of the containment liner and isolation equipment.

(a) A piping diagram for each penetration showing all valves in lines leading to atmosphere or closed systems on both sides of the containment liner. Locate missile shielding in relation to the valves.

(b) Type of valve including leakage characteristics (both past the valve and out the stem) at accident pressures.

(c) Approximate location of valves and closed systems in terms of feet of piping from the liner.

(d) Method of valve actuation and remote position indication in control room.

(e) Radiation shielding provided (for manual isolation valves which could contain fission products or which are located in the auxiliary building).

(f) Signal to operate valve.

(g) Redundancy and fail-safe characteristics provided in the control circuits (wiring, relays, etc.), up to the valve operators.

(h) Power source required to operate the valve and valve control circuits.

(i) Location of test connections and description of method which will be used to periodically demonstrate that the two barriers (valves or closed systems) are leak tight.

(j) Normal position of valve.

(k) Penetrations other than those associated with the safeguards which continue to be used after isolation.

(l) Position of valves during integrated leak-rate test.

(m) Location of water leg and means for assuring that water is in the leg if no injection system is provided for these.

(4) Discuss in detail why seal water injection is not necessary for all cases where it is not included in (3) above.

F. Describe the steam generator blow-down system, including control and radioactivity monitoring systems.

G. Will provisions be made for installation of the necessary equipment to perform an accurate integrated containment leak-rate test at design pressure?

H. Core Thermal and Hydraulic Design

Your presentation of the thermal and hydraulic capability of the core design consists principally of evaluations of steady state and transient DNB ratios and fuel temperatures for the hottest core location. A complete assessment of the conservatism or safety of the design requires some understanding of the condition of the entire core during normal and transient situations so that we can evaluate the margins available before large numbers of fuel rods exceed design limitations. Thus, our evaluation of the design must be based on the overall core condition, as well as that of the so called hot spot. A presentation using these considerations should be made as follows:

1. Prepare a distribution curve showing the fraction of the core (or number of rods) operating at the various power levels for design and overpower conditions.

2. Using the statistical W-3 DNB correlation and the above distribution, determine the corresponding DNB ratios and the statistical number of fuel rods that could experience DNB.

3. Perform an uncertainty analysis by arbitrarily assuming certain errors in major parameters used in calculating the number of rods experiencing DNB. For example, calculate the number of rods with DNB, as a function of possible percentage errors in the DNB correlation, power distributions, flow rates, and power levels.

VI. Engineered Safeguards

A. We understand that an accumulator system is to be provided in the safety injection system which will rapidly inject borated water into the vessel following a primary pipe rupture. Please provide details concerning its design and operating characteristics in the following areas:

(1) State your design and performance criteria for the safety injection system concerning clad melting, fuel melting and metal-water reaction for a range of break sizes and locations. Assume that minimum safeguards operate.

(2) Provide a drawing of the location of the system piping, valves, and vessels in the containment.

(3) Describe the dimensions, volume of liquid and gas, applicable codes, temperature, etc., of the accumulators, valves, and piping.

(4) Provide a P&I diagram showing the function of all lines connecting to the vessels.

(5) Provide plots of injection rate as a function of time for 0-psig and 200-psig at the injection nozzle.

(6) How is the proper boron concentration in the accumulators maintained and monitored?

(7) How are the accumulators pressurized? Do they remain connected to the pressurizing system?

(8) Will any of the accumulators be allowed to be out of service during reactor operation? If so, describe the circumstances.

(9) Are all valve positions indicated in the control room?

(10) How will the system be periodically tested? Will the valves be tested for proper function between tests?

(11) What elevation is the water in the accumulators in relation to the primary nozzles?

(12) Discuss the design criteria for the check valves in the safety injection and accumulator lines to assure proper operation of the system under normal and accident conditions.

B. Safety Injection System

(1) What criteria pertaining to pipe motion under hypothetical earthquake forces will be used in the design of the piping and nozzles associated with the injection lines connected to the primary system?

(2) Assume that safety injection has been delayed following a pipe rupture, metal-water reaction has occurred, and the temperature of the primary pipe and injection nozzle has increased due to escaping hot gases. Will the thermal shock upon initiation of injection under such circumstances be accomodated by the nozzle without failure? What is the limiting initial temperature?

(3) Plot the approximate horsepower requirements and flow as a function of discharge pressure for the residual heat removal pumps, charging pumps and the high head injection pumps.

(4) Describe what methods and instruments are available under post-accident conditions to verify that safety injection, or core dousing is operating to cover the core.

(5) Provide the approximate dimensions, wall material and wall thickness of the refueling water storage tank. Present the results and methods of a detailed stress analysis which indicates that the tank can withstand the stresses due to a hypothetical earthquake when filled with water. What is your allowable stress criteria for these loads?

(6) Describe the environment and provide a drawing of the location of the single header leading from the refueling water storage tank up to the various pump intakes. Please provide the approximate dimensions, including thickness, type of material and support of this pipe up to each pump intake. Also provide a stress analysis similar to that requested in (5) above.

(7) There appears to be only a single high pressure pipe leading from the high head pump discharge to the injection system in the containment. In view of the importance of providing high head injection for certain break sizes, discuss whether there is a backup to the high head injection system and analyze the consequences assuming only the backup operates from diesel power. This should be done for a spectrum of small break sizes in the piping connected to the primary system.

(8) Discuss the safety margin between expected operating pressures and the design pressures of the systems discussed in (7) above.

What type of failure could lead to pressures in excess of design pressure?

(9) State the piping code used for each piping run shown on Figure 6-1.

(10) In Figure 6-1 it appears that provisions have been made to permit high head injection after recirculation has been initiated. Discuss the circumstances that would require such operation. Is operation of a residual heat removal pump required? If so, discuss the independence and reliability of this mode of operation.

C. External Recirculation Cooling Loop

(1) You have indicated that Figure 6-1 of your application will be revised. Please include all relief valves and associated exhaust piping in the revision. Describe the basis for sizing each relief valve. If relief is to other than a closed system or containment, discuss the consequences of release of contaminated water to the environment.

(2) In view of the importance of the single sump return line for recirculation, discuss the location of the line and protection provided to prevent damage up to the residual heat removal pumps. What margin is incorporated in the design to withstand forces due to earthquake, pressure and temperature, without loss of function. Are working stress limits exceeded under hypothetical earthquake loadings?

(3) State the criteria for debris size which will be precluded from entry to the recirculation system. Provide a drawing of the sump intake to show how this will be accomplished. What size debris would result in flow restrictions or failure of safeguards components? What is the inlet velocity? How much water must be injected in the containment before recirculation can begin? Describe the pre-operational program to be used to remove debris which has accumulated in the piping during construction. Of particular interest are the sump return and containment spray lines.

(4) Which components in the loop will be allowed to be inoperable during reactor operation? Is redundancy of function still available?

(5) Provide a plot of pressures and temperatures in the residual heat removal, component cooling, and service water systems as a function of time after the accident. (Assume minimum safeguards).

(6) Describe in detail the criteria for leak tightness or positive flow of air in the primary auxiliary building through the filter units. Describe the provisions made at the entrances to maintain a vacuum. What is the flow rate, vacuum, motor and fan size, and duct location of the exhaust system? Describe the filters to be used and indicate redundancy and valving to divert flow, etc. Compare the largest recirculation system leak during post-accident recirculation which could be accommodated by the auxiliary building ventilation system with the maximum leakage due to packing or seal failure in one of the pumps or valves.

D. <u>Component Cooling Loop</u>

(1) Please provide the following information concerning the operation and design of the component cooling loop.

(a) What portions of this system are located outside of the auxiliary building? Can these components be isolated from the loop?

(b) Would any credible temperature increase overfill the surge tank? Where does the overflow discharge?

(c) What is the volume of the surge tank? What is the normal free volume above the water in the tank? What is the approximate volume of the loop?

(d) Is this system monitored or inspected for leaks to the service water system? If so, what size leak could be detected during normal operation and what size leak would be considered acceptable? Relate the basis to off-site dose.

(e) If the residual heat removal loop develops a considerable leak to the component cooling loop, where is the excess water in the component loop disposed of? How is the disposal accomplished?

(f) In view of the importance of maintaining core cooling, discuss the capability for providing backup cooling water to the residual heat exchangers such as from the service water system.

(g) Which components inside the containment will not be isolated from the loop after the accident? If the accident damages these lines what leakage rate from the loop to the containment would occur?

(h) What indications and/or alarms are provided to the operator concerning the level of the surge tank?

(i) How fast can water be made up to the surge tank? What is the source? Is emergency power available for this function?

E. Provide a drawing of the service water system. Indicate the type of valve (remote, etc.) in each location and discuss the ability to rapidly isolate portions of the system that are not protected according to Class I criteria (such as those in the turbine building). What is the flow rate required to operate the fan-cooler and the component cooling loop?

F. <u>Fan-Coolers</u>

(1) In relation to the <u>fan-cooler</u> design, please provide the following information:

(a) Are the cooling coils to be of the finned type?

(b) What heat and mass transfer coefficients will be used in sizing the units? What is the basis for selecting these values? How is the presence of non-condensable gases taken into account?

(c) What is the composition assumed for the steam-air mixture into and out of the units?

(d) How is the condensed liquid removed from the unit without restricting heat transfer or flow of containment air through the coolers? What quantities of condensate are expected initially? What additional pressure drops could occur due to this type of restriction?

(e) Provide information on the performance capability of the motors to show that they can operate under the accident conditions for several days.

(f) How will the cooling coils be periodically leak tested? What is the accuracy of this method?

(g) If a unit develops a leak during service, what indications would the operators have to aid in identifying the source?

(h) Provide a drawing locating all components in the fan-cooler units and ductwork showing intakes and outlets to afford good mixing.

(i) Is an experimental proof test or model test planned to demonstrate proper performance of the fan-coolers under accident conditions? In lieu of tests, what industrial practice with similar designs and conditions is applicable to your design?

(j) What is the inlet and outlet cooling water temperature under normal and accident conditions? What is the flow rate?

(k) What would be the leakage rate of service water to the containment if one cooling tube was completely severed assuming the containment is essentially at 0-psig? How much time would be required to reduce boron concentration by 100 ppm after the MCA?

(2) State the design criteria for the particulate filters and demisters in the fan-cooler system. What pressure drop is assumed accross the demister?

G. <u>Containment Spray and Iodine Removal System</u>

(1) We note that the containment spray system serves as the only means to reduce the iodine concentration in the containment post-accident. Please provide the following discussions regarding this system:

(a) It appears in Figure 6-1 that one failure in both sides of the system or in the injection tank lines would render the entire system inoperable. Please provide a discussion addressed to the redundancy of piping, storage tanks, valving, and pumps to show that the proposed system will provide the design function.

(b) What will be the concentration of the thiosulfate solution to be stored in the tank? What is the saturation temperature for this concentration?

(c) What size pipes will lead to and from the tank and how will they be checked to assure that there is no flow restriction?

(d) What problems could occur in storage of this solution? Will it require replacement at frequent intervals? If so, will replacement be done during reactor operation requiring the iodine removal system to be off-line.

(e) Are there any requirements to keep the solution at a certain condition such as above ambient temperature, agitated or in an inert atmosphere, etc.? What instrumentation and alarms will be provided to assure that any such condition is met?

(f) How will proper operation of the system at design flow rates be periodically checked?

(2) We note that the thiosulfate injected containment spray relies on the ability of the solution to sorb all forms of iodine on the spray droplets. Since this system is the only one used for iodine removal, we understand that a testing program is planned to demonstrate its effectiveness. In this regard, please provide the following:

(a) A detailed description of the proposed test and test equipment to be used.

(b) A discussion on how the effectiveness of this system to remove molecular, organic, and particulate forms of iodine under containment conditions will be demonstrated. Will the partition coefficient upon respray be studied?

(c) A list of all parameters to be studied.

(d) A discussion on how the results of the experiments will be scaled up to the containment size.

(e) We understand that this R&D program will not be completed until after the approximate time of issuance of a construction permit. If the results show that the injected spray system will not function as described, do you propose a system for iodine removal on which more experimental information is now available? Discuss your intentions in this regard.

(3) The capability of containment spray systems to condense steam and reduce containment temperature has been the subject of recent discussions with Westinghouse. Please provide the following information related to the capability of your proposed containment spray system to reduce pressure.

(a) The theoretical and/or experimental data used as the design basis for the system presented which will provide convincing evidence of the performance of this system as a spray condenser at the required duty under the prevailing conditions. Specific and quantitative information directly applicable to the design of this system is requested. A quantitative estimate of the effect on heat transfer resulting from the considerably greater air concentration that is usually associated with spray condensation should be given. Provide the expected air concentration in the containment vessel.

(b) The performance characteristics of each of the principle components of the system such as pumps and nozzles in order to show how the proposed system design reflects the design basis.

(c) Describe the plans you have for an experimental proof test or model test which will be performed to demonstrate the assumptions used in the design basis of the spray system.

(4) Plot the rate of condensation of water on surfaces in the containment as a function of time following the MCA.

H. <u>Emergency Power Source</u>

(1) Describe the fuel storage for the diesel generators and the active components which are required to provide fuel to the diesels. Discuss the reliability and/or redundancy of these components. What is the power source?

(2) State the time required to start the diesels and bring them up to design loads.

(3) What is the power rating of each unit?

(4) What is the power source for starting the diesel? Is this equipment redundant?

(5) Discuss the fire protection system for the diesels and describe the power source for active components in this system.

VII. Accident Analysis

A. Design Basis Information

(1) To enable us to ascertain the adequacy of your containment to withstand the credible post-accident pressures, the following information is necessary. Please list all assumptions for each plot requested.

(a) Plot containment vessel pressure using your model and assuming that all heat stored in the fuel goes to flashing steam and not to heating subcooled water in the sump when the vessel melts through. Assume no core cooling but that the other minimum safeguards operate.

(b) Provide the above plot assuming that the minimum safeguards for reduction of containment pressure are 25% and 50% less effective than designed.

(c) Provide the same plot as in (a) assuming the accumulators operate along with minimum injection.

(d) Plot reactor vessel water level as a function of time following a spectrum of break sizes assuming (1) that two accumulators operate and (2) that only one operates. In both cases assume that the minimum injection flow exists after accumulator injection.

(e) Plot pressure at the safety injection nozzles both in the hot and cold legs as a function of time for various size breaks.

(f) Provide a plot of liquid volume and temperature in the reactor sump and containment floor as a function of time after the accident. (Assume no core cooling). Two plots should be presented, one assuming the molten core heats the sub-cooled water and other assuming this energy goes to flashing steam.

(g) Plot core reactivity and power as a function of time for different size breaks assuming a conservative positive moderator coefficient. Indicate the time at which scram would be assumed to occur but for purposes of analysis assume no scram.

(h) What is the total percent metal-water reaction assuming (1) that two accumulators and minimum safety injection operate, and (2) that only one accumulator and minimum safety injection operate and (3) same as (1) but assume no heat transfer from core during blowdown for the largest break. Consider a spectrum of pipe break sizes except for (3).

(i) For the worst case in (h) above, provide a similar plot assuming two accumulators operate but the safety injection is delayed 2, 5, 10 and 20 minutes after the MCA.

(j) Plot flow rate provided by two accumulators and the minimum safety injection as a function of time for various break sizes. On this same plot draw lines for each break size which shows the rate which you consider necessary to limit clad failure to 5% of the fuel rods.

(k) Plot the weight percentage of clad and fuel at a certain temperature as a function of time assuming two accumulators operate along with safety injection following various pipe break sizes.

(l) What is the maximum time interval that the diesels could be inoperable at various times after the largest break and still prevent core melting?

(m) Provide a time sequence of events both automatic and manual which the operator must observe or perform during the MCA. Indicate the time that each engineered safeguard is actuated including containment isolation.

(n) Plot the steam generator pressure, water level and steam line valve positions as a function of time after the various size primary system breaks assuming the operator takes no action which would affect the steam generators. What action would the operator be required to take in the first two hours? What is the condition of the steam generator after several days? Assume no offiste power. Relate your answer to leakage potential of containment atmosphere through the steam lines.

(2) If the RCC's must scram to limit the consequences of the accident, include the following information for the spectrum of break sizes:

(a) Scram Signal

(b) Time to scram initiation

(c) Effect of blowdown forces on scram time.

(3) Please discuss the significance, in relation to the maximum accident analysis, of power profile changes as the core fuel is depleted.

(4) What is the volume of the secondary side of a steam generator? Indicate the fraction of this volume occupied by water and the temperature of the water at 10% power level and 100% power level. What additional containment blowdown pressure would result if the MCA occurred along with a steam generator failure at either power level?

(5) Discuss the affect of pipe break location on the consequences of the loss of coolant accidents considering both positive and negative moderator coefficients.

B. Reactivity Accidents and Considerations

(1) We understand that the analytical methods and results of the control rod ejection accident for this reactor will be very similar to those described in Westinghouse's recent work on Cosolidated Edison Company of New York, Inc., Docket No. 50-247. These results were reported in WCAP-2940. However, to complete our evaluation of this accident for the H. B. Robinson facility we will need the additional information:

(a) Provide a quantitative discussion of the significant differences in the input parameters used in the rod ejection accident analysis for the H. B. Robinson plant and those used in WCAP-2940.

(b) Provide a quantitative discussion of the effect on the consequences of the accidents that result from the changes described in (a) above.

(c) Provide supplementary information describing the enthalpy distribution in the core fuel for both the pre-accident condition and the most pessimistic post-accident condition. This could be conveniently presented as a set of curves showing the fraction of core fuel having an enthalphy equal to or greater than the value of H for each condition.

(d) Discuss the criteria (and their bases) upon which you evaluate the acceptability of the enthalpy distribution in the fuel during power excursions.

(2) The results of the rod ejection cases described in WCAP-2940 were shown to be sensitive to the scram delay time. Please discuss the experimental justification for the range of values used in that study, and indicate their applicability to the H. B. Robinson unit. In addition, provide a discussion of the effect that accident conditions within the core (due to rod ejection) will have on the performance of the scram function. Consider such items as: the effect of thermal-hydraulic conditions on the expulsion of water from the RCC guide tubes as rods come in, transient induced pressure effects,

rod bowing, etc. Also provide a quantitative discussion of the effects of the moderator coefficient on the sensitivity of consequences of the accident to trip delay.

(3) We understand that fixed poisons may be used, if necessary, to control the moderator coefficient in plants of this type. In this regard, please provide the following information:

(a) Discuss the analytical and/or experimental techniques and procedures (time schedule, etc.) you intend to employ to evaluate the potential requirements for controlling the moderator coefficient. Include considerations of the effect of the coefficient on reactor stability as well as its effect on the consequences of prompt power excursions.

(b) Describe the way that the fixed poisons would be incorporated within the core. Also discuss the way their inclusion would affect core design characteristics.

(4) Westinghouse has recently expanded their analyses in the areas of Xenon and coolant flow stability for reactors of the H. B. Robinson class. Much of their work has been reported in connection with the Florida Power and Light Company's application - Docket Nos. 50-250 and 50-251. The information was specifically presented in reports WCAP-2983 and WCAP-2987. To facilitate the staff's analysis of these areas for the H. B. Robinson plant please indicate your position on the information contained in these reports.

(5) Discuss the possibility and potential consequences of rapid insertion of the unborated, relatively cold primary coolant remaining in the primary system as a result of displacement by actuation of the safety injection system and accumulator system. Assume that the control rods do not go in. This discussion should include various size breaks for both beginning and end of core life.

C. <u>RCC Drop Accident</u>

(1) Provide the calculations or tests that have been performed to assure that a flux decrease caused by dropping any of the RCC's into the core while at power will be detected by <u>one or more</u> of the nuclear detectors, and that a negative signal output less than approximately 10% will not require a turbine cutback.

(2) If one of the four high level channels is out of service will protection for this type of accident still be provided by the remaining detectors?

(3) How will this condition be distinguished from a normal transient core imbalance?

(4) What is the time relationship between the neutron sensor signal which would cut back the turbine load and the signal which would cause RCC withdrawal to restore reactor power?

(5) How is the proper turbine cutback determined? (i.e., How much is load output decreased and what determines the amount of cutback?)

D. Please perform the following startup accident analysis: Assume the simultaneous withdrawal of all rods from their full-in positions under initial cold, clean, 1% shutdown conditions. Credit should be taken only for scram initiated by the nuclear linear level safety channels set at their highest trip points and the inherent negative feedback within the reactor itself. Will any fuel damage result?

E. Please show, by analysis, that the loss of coolant flow in one primary loop without operator action would not result in fuel failure. What is the minimum DNBR under this condition? Consider the effects of positive moderator coefficients. The analysis should include cases of initial two loop operation as allowed by permissive interlock circuitry.

F. To illustrate the effect of the iodine removal efficiency of the sodium thiosulfate injected spray system on potential offsite doses, please provide the graphs out to 30 days described below, where:

γ = effective reduction rate of soluble iodine (hr^{-1})

r = production rate of insoluble forms of iodine (% of core inventory per hour)

Meteorology - same as page 12-58 of application

Leak rate = 0.1%/day

Assume that production of insolubles stops when the 25% of total core inventory assumed to plate out initially has been dissipated.

(1) Plot on one graph the amount of iodine remaining airborne (of the total core inventory) as a function of time for γ = 0, 5 and 10 for each of the values of r = 0, 0.03, 0.1 and 0.5.

(2) The increase in dose per unit time at the site boundary and low population zone, as a function of time using the assumptions in (1).

(3) The integral of the curves requested in (2) above showing the total dose as a function of time. For times in excess of two hours describe the persistence model used. If it is the same as described in the application, please explain why the frequency of observations

of instances of persistence is more applicable to accident analyses than the overall hourly frequency of persistence.

G. Assuming that there is no core cooling, list the amount of hydrogen which could be formed from the following sources: (a) metal-water reaction, (b) decomposition of UO_2 to U_3O_8 under high temperature, and (c) radiolytic decomposition of water as a function of time after a major loss of coolant accident.

(1) Assuming it burns upon exit from the primary pipe, discuss the local affects due to the burning hydrogen jet.

(2) What ΔP in the containment would occur if the total amount of hydrogen were rapidly burned starting from 0 and 10 psig?

(3) Discuss in detail the model used to estimate the amount of radiolytic decomposition listed above.

H. You have indicated that you are studying the capability to shut down the plant assuming that the emergency turbine driven feedwater pump does not operate upon loss of offsite power and turbine trip. Please provide the results of this study and indicate which systems must operate to effect safe shutdown.

I. <u>Steam Generator Tube Ruptures</u>

(1) Provide the results of a detailed analysis of the consequences of the rupture of a single steam generator tube.

(2) Approximately how many steam generator tubes would have to rupture simultaneously in order to (a) lift a steam system safety valve or (b) cause significant fuel clad failures?

(3) Discuss the probability that failure of one steam generator tube would cause other tube failures. Provide an analysis to show how many could fail and still not exceed a whole body dose of 1/2 rem at the exclusion distance. How is this situation affected if the main steam isolation valve from the affected generator fails to close?

(4) What is the basis for setting the maximum allowable radioactivity inventory circulating in the primary system? What is the primary coolant activity corresponding to defects in 5% of the fuel elements used in the accident analyses in terms of isotopic inventory or concentration in the primary system? Provide the basis for the isotopic inventory assumed.

(5) Plot the amount of additional water which must be added to the primary system during the shutdown process as a function of the number of tube ruptures? What sources are available? What action by the operator and various engineered safeguard systems is required? Plot the pressurizer level as a function of time for

for various numbers of tube ruptures assuming minimum high head safety injection is operable.

(6) Describe the basis for using an iodine partition factor of 10^{-4} for releases from the secondary system water.

J. Please make a complete list of all possible causes of the atmospheric steam dump action. Using the expected maximum concentration of fission and corrosion products in the primary system, and the maximum amount of steam generator leaks which would not force isolation of the steam generator, calculate the offsite doses resulting from the atmospheric steam dump.

K. In the refueling accident, consider the case of a fuel element which is dropped, damaged as assumed, and comes to rest on its side in the pool. Will the radiation levels in the containment force evacuation before the element can be uprighted? Will the fuel then become hot enough to release much more fission products than assumed? Discuss the release of iodine both for this case and for the one described in the PSAR. Calculate the doses for this case if they are significantly different from those obtained in the PSAR.

L. Analyze the consequences of a rupture of the volume control tank and provide data on the flow rates and cleanup constants used to determine the fission product concentration. How many curies of noble gases and iodines are available for release by this mechanism? What specific assumptions were made to cause the thyroid dose to be insignificant with respect to the whole body dose?

M. In the gas decay tank rupture accident, what constants were used to calculate the inventory of this vessel? What is the isotopic breakdown of the contents? What is the average holdup time in this vessel? Why is there no significant thyroid dose?

N. What failures or maloperations would be required to overpressurize a gas decay tank from the nitrogen bottles thus causing a leak or rupture? What are the design and operating pressures of these tanks?

O. Indicate the extent of core damage anticipated in the event rupture of the largest steam line occurs with one rod cluster control assembly stuck in the fully withdrawn position at the end of core life (most negative temperature coefficient). What is the maximum $k_{effective}$ attained? Compare the maximum steam generator tube sheet stress experienced during this incident with the yield stress and discuss the effect of this accident on primary system integrity. If primary system pressure pulses can be initiated by fuel failures, discuss the effect they have on primary system integrity.

P. The acceptability criterion for uncontrolled RCC withdrawal and turbine trip accidents is that DNB will not occur. What is the minimum DNB margin that will comply with this criterion? Similarly, for the loss of coolant flow incident, it is stated that clad failure will not occur. Indicate the margin to DNB, clad melting temperatures, and clad yield which are assumed as limiting in your analysis.

Q. If the dam should fail, discuss the provisions which have been made to assure that sufficient cooling water is available. Are the structures and components which will contain and transport this water to the cooling systems Class I? Indicate which cooling system will be used to remove decay heat from the core. Is this cooling water also available to all safeguards systems?

R. Analyze the offsite thyroid dose resulting from complete rupture of a fan-cooler tube assuming 100% core melt. Provide all assumptions made. You may terminate the calculation when containment pressure is reduced below that of the service water (about 3000 seconds).

S. Provide the plutonium (Pu-238 to Pu-241) isotopic concentrations which exist in the core at the end of core life. Discuss the credibility that if core meltdown occurs, sufficient quantities could become airborne to contribute significantly to the offsite dose. Explain your assumptions.

VIII. Containment Structure

A. Structural Design

(1) It is considered that some of the apparent margin present in the load factor design approach might be associated not only with overload and probability considerations, but also with uncertainties in the calculational methods and design equations that are utilized. If the margins are to be considered primarily as overload margins as indicated on page 5-17 of the application, an evaluation of the validity of using these margins in this manner is required. In particular, show that your design analysis procedures assure that all structural elements are treated conservatively, placing no reliance on the specified factors to provide for under-strength due to analytical simplification and assumptions in the structural analysis.

(2) Explain in detail the basis for the load factors selected. State if ultimate strength or elastic design procedures will be used in the design of the elements of the containment, particularly those subjected to bending and shears. Describe in detail what is meant by "the required limiting capacity of any structural element". Please discuss the design procedures in this regard.

(3) With respect to the longitudinal prestressed elements of the structure, the design limits are not clearly specified. Provide the stress limits for concrete at transfer of prestress, under sustained prestress and at design loads. For the factored load conditions, identify if flexural cracking is permitted, if membrane tension is permitted and if the intent of the designer is to design to the ultimate strength of the section in flexure or tension, as applicable. In particular, amplify the meaning of the statement on page 5-19 of the application that "the design limit for tension members (the capacity required for the design loads) will be based on the yield stress ...of the prestressing tendon".

(4) It is stated in the application that structure live load will be considered in the design of the containment. It is noted that these live loads are incorporated in the dead load factor of the design criteria. In view of the larger load factors normally associated with live loads, and in view of considering live load items such as cranes, pumps, etc. as dead loads, the basis for neglecting impact and dynamic load characteristics of such equipment should be provided. Consideration should be

given to providing a separate load factor for live loads. It is requested that the design stress criteria be revised to include a separate design live load factor or that your present approach be justified in detail.

(5) The handling of thermal loads needs amplification. In particular, provide the thermal gradient across the containment liner and concrete structure as a function of time, indicate the design conditions under which thermal loading due to liner and concrete temperature gradients are critical, and provide the loading diagrams for the separate liner and concrete thermal contributions.

(6) It is noted that ASA standard A58.1-1955 has been utilized to classify the site within a 25 psf zone. In recognition of the critical nature of the structure, it is requested that more detailed information on the selection of the 30 psf loading be submitted. In particular, the design wind speed, stagnation pressure, drag coefficient, gust factors and assumed vertical variation of pressure on the structure are of interest. What is the basis for the selection of the values supplied?

(7) It is indicated that the structure will be analyzed for tornado loading. The basis for the selected wind speed, equivalent pressure and 1.25 load factor is requested. In addition, a design load factor equation to indicate how this loading will be treated in combination with dead and live loads is requested.

(8) On page 2-29 of the application is is suggested that the design wind at the site will be the "once in fifty years" wind. The basis for this selection is requested.

(9) A two psig internal negative pressure has been identified as a design loading resulting from an 80°F differential cooling of the containment. Relate the selected operating and/or environmental conditions that could cause such a differential and state why vacuum relief is not considered necessary.

(10) In justification of the adequacy of the selected proof test pressure of the completed containment structure, provide a comparison table or preferrably stress charts of the calculated stresses in the (a) circumferential shell reinforcing steel, (b) axial shell tendons, (c) dome reinforcing steel, and (d) base reinforcing steel for the following three conditions of loading:

1) Test condition -

$L_1 = D + P_t$

where P_t = proof test pressure

2) Accident condition -

$L_2 = D + P_a + T_a$

where P_a = peak accident pressure
T_a = peak temperature of accident transient

3) Accident plus earthquake condition

$L_3 = D + P_a + T_a + E$

where E = earthquake load (hypothetical)

(NOTE: All other notations are in accord with the factored load equations.)

Where stress ranges exist due to earthquake loadings, specify the maximum stresses and identify the range. In the event significant differences in stresses exist between conditions (1) and (2) or (1) and (3), provide a discussion in support of the selected test pressure including the reasons why an increased test pressure or design modification of both cannot be considered to obtain an improved agreement between the stresses.

We believe the acceptance criterion for selection of a proof test pressure is the development of stresses in the structure under test condition (1) equal to or greater than those calculated for condition (2) and (3). The intent of this is that the containment leakage under condition (2) or (3) may reasonably be expected not to exceed the leakage measured following a proof test (condition (1)) in which the principal loadings are duplicated or exceeded. Comparable loadings on the structure may be expected to produce comparable strains on the liner which is considered as the leakage-limiting boundary of the containment. The proof test thereby serves not only to verify structural integrity but also confirms expected leakage behavior.

(11) Discuss the possiblity that failure of the earth dam would have an adverse affect on the containment or other structures important to plant safety.

(12) From the description provided in the application, the criteria concerning methods by which you propose to handle shear loads is not clear.

(a) With respect to longitudinal shear, provide (1) the basis for the conservatism in the crack width assumption, (2) the calculational method, the dowel shear stress, and the margin against shear failure in the reinforcing steel, and (3) the local stess in the concrete and its margin of failure with respect to crushing.

(b) With respect to radial shear, describe (1) the extent of tensile or compressive membrane stress under design basis and factored loads, (2) the extent to which reinforcing steel will be provided to resist radial shear, and (3) where tension on the section is allowed, the supporting basis for the applicability of ACI Code provisions for the situation.

(c) With respect to tangential (lateral) shear, provide the criteria for and a description of the reinforcement provided against such shear.

(d) In all cases describe fully the extent to which the liner will be relied upon to carry shear and the liner shear deformations required.

(13) A critical feature in the design is the accommodation of design loads at the equipment and personnel access hatches. Provide detailed drawings of the reinforcing and strand patterns in the shell and around the opening. Provide a design analysis of the openings comparing the stress patterns in the vicinity of the openings under the selected proof test pressure with those anticipated under design basis accident conditions. Describe in detail how the prestressing wire, bar, or strand are to be anchored to the opening, and how vertical strain incompatability between the structural steel opening and prestressed concrete cylinder sections will be accommodated. Describe fully the ring analysis that is proposed. How will the structural behavior before and after vertical cracking be considered and how will the stiffening effect of the ring be accounted for in the design analysis? How will local shear and bending stresses be accommodated and what margin will exist with respect to failure in shear?

(14) It is noted that the equipment hatch and personnel hatch protrude some distance from the cylindrical surface of the main structure. Discuss the potential for increased leakage or improper operation of the access due to earthquake and pressure forces.

(15) The assumption that the base slab will behave as an annulus appears important in the structural design of the containment. Please provide information on the validity and conservatism of the assumption that the central sump will offer no bending or deflection resistance to the base slab. In addition, describe in more detail the analytical procedures to be used in base slab design.

(16) Provide information relative to the amount of mild steel reinforcement required to provide crack control. Is failure to develop tendon bond taken into account?

(17) It is noted that the design as it now exists, provides for use of grouted tendons. What are the bond development lengths for the tendon systems proposed? Given an anchorage failure and the bond development lengths cited, presentan analysis of the consequences of the failure or series of such failures under design basis accident loading.

(18) The means of providing the prestressing anchorage zone reinforcement at the cylinder-dome transition requires amplification. Provide the analytical procedures that will be used for calculating the bursting and spalling stresses. Also provide a description of the magnitude of these stresses and a detail of the reinforcing that will be used.

(19) Discuss the crane design provisions to resist seismic loading and discuss the method of analysis.

(20) Will a critical damping of two percent also be used for the dome and other portions of the entire containment structure?

(21) A more detailed description of the pile design is required. Describe how the piles will function, by friction or by point bearing, or by a combination of these actions. How is the behavior affected by the soil properties around and below the piles? Provide information on expected site liquefaction, negative skin friction due to compression of softer overlying strata, and uplift force effects on pile action. In this discussion consider the effects due to the hypothetical earthquake as it might lead to a serious instability in this case. Present the load test data on the pile tests conducted on site.

(22) The proposed idealization of the structure of a three lumped mass system model is not understood. Provide detailed information to show the adequacy of this idealization under the various combined loadings.

B. Liner Design

(1) Discuss the method chosen for liner attachment. Provide details of the attachment spacing and type, and typical discontinuity details for the slab-cylinder and slab-sump transitions.

(2) Provide an analysis of the elastic stability of the liner under the applied compressive loads due to prestress, and design basis accident conditions.

(3) Provide the fatigue loadings that will be considered in the design of the liner and its attachments. Discuss the effects of vibration loading of the liner from its penetrations under both normal operating and accident conditions. Discuss the provision that will be included to preclude excessive loadings of this type from causing increased leakage of the liner.

(4) The proposed piping penetration designs indicate that the pipe lines which penetrate and are joined to the containment liner will be anchored at the wall of the containment. State the design criterion which will be applied to ensure that, under a postulated pipe rupture, the torsional, axial, and bending forces transmitted to the penetration will not breach the containment. Also include the design criterion which will be applied to ensure that pipe rupture is precluded between the penetration and containment isolation valves, since these pipe sections represent an extension of the containment boundary.

C. Materials of Construction

(1) Concrete

(a) Since shrinkage and creep will greatly affect both the accuracy of predicting the final prestress and structural behavior under proof test loading, provide the specifications, procedures, and tests used to develop and verify the design creep and shrinkage properties. Identify the admixtures to be used and provide the basis for determining the effect of these admixtures on shrinkage and creep.

(b) Specify the type of cement selected and explain the basis for the selection.

(2) Tendons and Anchorages

(a) Provide the criteria for acceptance of a tendon anchorage system suitable for this application. Include anchorage performance requirements under cyclic and rapid loading. Analyze how these requirements relate to the most severe design basis accident load conditions. Identify the system chosen and provide details of the anchorages.

(b) Discuss the relative merits of galvanized vs ungalvanized wire/strand and indicate the basis for your selection.

(c) Provide the specifications and factory control requirements that will be imposed in the manufacture of the tendon wire or strand.

(d) Furnish details of the tendon coupling and describe how it will be protected from corrosion.

(e) Provide dimensional data and test results (minimum elongation and minimum guaranteed ultimate tensile strength, dynamic performance and tendon tests) to support the adequacy of the prestressing system chosen.

D. Construction

(1) General

(a) Detail the codes of practice that will be followed for construction. Describe where and to what extent standard practice for construction will be equalled, exceeded, and, if applicable, not met.

(b) Provide a list of all materials of containment construction and indicate the on-site user testing that will be done for each material.

(2) Concrete

(a) Describe the mixing, transporting, placing and curing procedures to be used.

(b) Describe the concrete quality control program to be employed.

(c) Describe the construction procedures to be utilized to ensure proper bonding between lifts.

(d) Specify the limit to be placed in the chloride content of the concrete mixing water.

(3) Steel

(a) Detail the methods to be used for reinforcing steel splicing and describe the quality control program to be used.

(b) Present test data to show the adequacy of the splicing system chosen.

(4) Liner

(a) Outline the codes that will be employed in the construction and testing of the liner.

(b) Present the sequence of construction of the liner with respect to concrete construction. Of particular interest is the construction procedure for placement of the liner on the base slab.

(c) Justify the use of only two percent radiography in the quality control of seam welding.

(d) Detail the extent to which weld ductility will be comparable to that of the liner material.

(e) Provide inspection procedures to be employed for the liner attachments and penetration welds.

(5) Penetrations

(a) Describe the hot pipe penetration cooling water system. What is the source of water? Is each penetration monitored for proper cooling?

(6) Inspection

(a) Describe the organization for inspection, qualifications and authority of inspectors, and extent of design group participation in the inspection.

(b) Justify the basis for the constructor (Ebasco) also performing the inspection of his construction operation.

(c) Provide a description of the prestressing sequence, procedures, and tendon stress verification methods.

(d) Provide the method used to grout the tendons. What cleaning agent will be used prior to grouting?

E. Acceptance and In-service Surveillance

(1) Acceptance

(a) Describe the sequence of procedures for containment proof testing. Provide the criteria for structural acceptance and, where applicable, the general strain and deflection tolerances that will be permitted.

(b) Provide the instrumentation program to be employed to verify the design, including protective measures to be taken to ensure performance over the interval between placement and use. Include numbers and location of instruments and the extent to which the location of these instruments will provide verification of the design.

(c) Describe the provisions incorporated in the design to monitor concrete creep and relaxation of tendon stress.

(2) Surveillance

(a) We believe an in-service tendon surveillance capability is essential for the lifetime of the containment structure. Describe the tendon surveillance program which you propose for inspection, verification of tendon tension, and examination for evidences of corrosion.

(b) As part of in-service surveillance for the containment structure, we believe a corrosion control program should be considered. Describe the design considerations and program planned to provide corrosion protection of (1) tendons, (2) reinforcing steel, (3) liner plates, and (4) piling (if applicable) both from the effects of stray currents, (galvanic corrosion) and the environment in which the component is located. Include the in-service surveillance considerations which will enable verification of the effectiveness of the proposed corrosion control system for the plant lifetime.

(c) Describe any instrumentation which will be permanently installed in the structure for long term surveillance.