Supp 6 50-313

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MAY 6 1968

Docket No. 50-313

Arkansas Power and Light Company
Sixth and Pine Streets
Pine Bluff, Arkansas 71601

Attention: Mr. J. D. Phillips
Vice President and Chief Engineer

Gentlemen:

Our letter dated April 3, 1968, conveyed a request for information on your Russellville facility which did not include structural aspects. Our review indicates that the information submitted on proposed structures for the facility is insufficient in several areas. During the February 28, 1968, meeting with your representatives, we indicated in some detail the nature of our concerns. In general, it will be necessary for you to provide information identifying structures, systems and components in each category, provide information on the proposed design of all essential foundations and structures, including information on loads, load combinations, allowable stress and deformation limits, methods of static and dynamic analysis, selection of materials, corrosion protective measures, quality assurance and control requirements, and testing and surveillance specifications. Examples of the kind of information needed are given in Enclosure No. 1. We are willing to further discuss any uncertainties you may have as to the type and extent of the material required

Since meeting with you on February 28, 1968, we have continued discussions with our consultants on your application. Additional information needs, identified through these discussions, are given in Enclosure No. 2.

Sincerely yours,

Original Signed by
Peter A. Morris

Peter A. Morris, Director
Division of Reactor Licensing

I understand that it has been determined, as a matter of policy, that this depth of information on structural design is necessary.
RB
5/7/68

Enclosures:
1. Req. for Inf. - Suppl. No. 1
2. Req. for Inf. - Suppl. No. 2

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cc: Messrs Harlan T. Holmes, Horace Jewell, Roy B. Snapp

RPB-3/DRL	RPB-3/DRL	RT/DRL	RP/DRL	DRL
ASchwencer:pt	CGLong	SLevine	RSBoyd	P.Morris
4-16-68	4-16-68	5-3-68	5-3-68	5-6-68

REQUEST FOR INFORMATION - SUPPLEMENT NO. 1

ARKANSAS POWER AND LIGHT COMPANY

Docket No. 50-313

11. CONTAINMENT SYSTEM

11.1 Methods and Criteria

11.1.1 Provide complete lists of:

(a) Class I structures, systems, and components
(b) Class II structures and systems
(c) Combined structures (i.e., having both Class I and Class II elements)
(d) Any Class I items housed in, adjacent to, or supported by, Class II structures.

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

11.1.3 State how the earthquake loads will be established for equipment in 11.1.2 above.

11.1.4 Describe the design methods used for the combined structures in 11.1.1(c) above.

11.1.5 For plant structures and equipment rated other than Class I, discuss the general design criteria related to the methods of handling seismic loadings and provide details for a structure and a system to illustrate how they are proposed to be implemented.

11.1.6 Apparently the foundations of the containment will rest on a Pennsylvania McAlester Shale having cleavage planes and slickensides. Because it is sensitive to accelerated weathering, and expansion when exposed, indicate how you will minimize this damage during the time between excavation and placement of foundations. Describe the protective measures planned. Give the shapes of the excavation and indicate how it will be drained.

11.2 Containment Structural Design

11.2.1 Provide a discussion of how tornado wind loading will be translated into direct, torsional and shear loadings on the structure. Consider the influence of the size of the funnel of the design tornado, its translation speed and the effect of a non-uniform pressure distribution. Discuss the basis and the method for the velocity evaluation of the tornado generated missiles.

11.2.2 The containment structure base may be located below ground water level. Will waterproofing or other protection be used between the soil and the containment. If not, evaluate the possibility and consequences of base mat cracking and of ground water reaching the liner and the prestressing tendons' anchors. Include the effect on liner stability and liner and tendon corrosion.

11.2.3 Provide:

a. A preliminary design drawing of the containment presenting details of the base slab, dome ring beam, cylinder-slab junction, and vertical buttresses, showing reinforcing, prestressing, and liner features, including liner anchors.

b. Scaled load plots for moment, shear, deflection, longitudinal force, and hoop tension, in order that an appraisal can be made of the significance of 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).

c. The normal operating thermal transients to be used in the design of the containment for the typical winter and summer days.

d. The transient thermal gradients through the containment envelope during the design basis accident for the typical winter and summer days.

e. A description of how torsional loads will be handled.

11.2.4 List and justify the values of E_c and μ_c you plan to use 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. The thermal load from the liner is also a function of the thickness of the liner plates, and of the yield point of the liner steel. The thickness of the two adjacent liner plates may vary by as much as 10%. Also, the maximum yield point, not established in PSAR, may differ from the minimum by as much as 25%-30%. Explain how variations in thickness and yield point of the liner are taken care of in the design.

11.2.5 For the loadings of the containment structure wall and dome, describe:

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

(b) 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 μ_c are considered.

11.2.6 Clarify whether the computer program used takes into account the cracking of concrete, and the resulting variation of E_c and μ_c. Will the program handle non-axisymetric loadings acting on non-axisymetric structures?

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

11.2.8 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.

(c) The fact that the mat is under radial tension and is supported on an elastic foundation.

(d) The fact that the adjacent ground restrains the deformation of the wall.

11.2.9 For the loadings of the base slab, describe the analytical procedures used to arrive at the forces, moments, and shears, considering the non-axisymetric loading and deformations of the mat. State whether transient thermal gradients have been considered.

11.2.10 State the elastic properties of the bedrock that have been used for the design of the mat.

11.2.11 Provide further clarification of the design procedures and stress limits to be used by describing the extent to which liner participation is relied upon to provide resistance to lateral (earthquake) shear. If liner participation is not included, describe how the corresponding strains are transmitted to the liner and their effect on the liner. Also, describe the general reinforcing patterns including layout and typical spacing for tension, flexural, shear, and crack control reinforcement.

11.2.12 Provide additional information on the proposed use of the one-third increase in allowable stresses. Use of this increase is not considered in keeping with normal practice, particularly with respect to the D - L - S - T loading. Discuss the problem and provide a criterion that considers biaxial and triaxial loading effects. Justify the values of shear (as a measure of beam strength in diagonal tension) for a structure of this type. Discuss the proposed design criteria in this area, keeping in mind possible biaxial tension stresses, and two dimensional cracking.

11.2.13 Under incident conditions concrete may be cracked and the crack pattern may be two dimensional. Explain how, under this condition, the shears are transferred through the section.

11.2.14 The reinforcing steel may be stressed to the yield point. Justify the use of this stress which is larger than the guaranteed minimum yield point of the liner (30,000 psi). Clarify whether, under certain conditions, the liner may be stressed beyond the yield point.

11.2.15 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.

11.2.16 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 order of magnitude of lateral earth pressure under seismic loading and how this is factored into the design.

c. 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.

d. 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.

11.2.17 The earthquake design response spectra shown in the PSAR, have been scaled from the El Centro spectrum. Indicate the degree to which the validity of this scaling was examined in connection with this site.

11.2.18 Discuss the stress levels and loading criteria that will be employed in the design for the maximum earthquake and the design earthquake, and the limitations on deformations utilized.

11.2.19 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 geometrical pattern, type, and spacing of liner attachments; and the analysis procedures, boundary conditions, and results with respect to buckling under the loads cited above.

(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:

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;
Shrinkage 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);
Ground water infiltration, earthquake, temperature loading, vacuum loading.

11.2.20 Provide information on:

(a) 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.

(b) The type, character, and magnitude of cyclic loads for which the containment liner will be designed. Discuss the pressure/thermal load variations considered and include an evaluation of the number of cycles generated by earthquakes.

(c) The analytical procedures and techniques to be used in liner anchorage design including sample calculations.

(d) 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.

11.2.21 Describe how elastic and inelastic buckling of the liner will be [illegible]nsidered in the design of the anchors. Discuss the possibility of unbalan[illegible] [illegible]ads acting on one or several anchors and provide a study showing that [illegible] [illegible]in reaction can occur and that massive buckling of the liner, and mass [illegible]ilure of anchors is excluded.

11.2.22 State the plastic strains that the liner material can accommodate without cracking.

11.2.23 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. Provide typical design details and computations.

11.2.24 It is noted that the bottom liner is not accessible for inspection during the life of the plant. It is therefore ve[illegible] [illegible]mportant 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.

11.2.25 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.

11.2.26 Describe the procedures for analysis of liner stresses around openings. Also, provide the method of liner design to accommodate these stresses and the related stress limits. Justify the proposed thickening of the liner at penetrations. Discuss the liner anchors at this location.

11.2.27 The general statement that all penetrations will be anchored into the concrete wall and that the anchorage will develop at least the plastic strength of the penetration sleeve must be supported by an explanation of what plastic strength is meant. Provide this explanation in terms of tension, bending, shear, or combined components as applicable.

11.2.28 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.

11.2.29 Provide 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.

11.2.30 Provide the following information:

(a) 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.

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

(c) Justify the length required to anchor the bars in cracked concrete, and the use of ACI Code 318 or any other code for concrete under biaxial tension, and cracked in two directions.

11.2.31 For large openings describe:

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

b. The stress analysis procedures that will be used in design.

c. 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.

d. 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).

e. 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?

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

g. 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.

11.2.32 List the spectrum of external missiles that the containment will be designed to withstand and the procedures to be used in checking the containment design to withstand such missile hazards.

11.2.33 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.

11.2.34 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.

11.2.35 Indicate the criteria by which reinforcing steel will be provided in the containment shell for crack control, considering possible reversal of stresses during cold shutdown.

11.2.36 If insulation is required, present preliminary design information, including proposed design requirements and performance specifications to ensure that the necessary insulating qualities will be achieved under accident conditions. The presentation should also include:

(a) The specified and tolerable temperature rise in the liner and the design safety factor provided on insulation performance.

(b) Means provided for fastening the insulation to the backing liner, for precluding steam channeling behind the insulation (through the top or joints), and for removing insulation panels.

(c) An analysis of the consequences of one or more insulation panels being displaced from the liner during, or as a consequence of, an accident situation.

(d) The consideration given to increased conductivity due to humidity and compression during accident pressure transients and precompression from structural and leakage testing.

(e) An evaluation of the compatibility of the insulation materials and steel liner (chemical reaction, etc.).

11.3 Materials

11.3.1 Justify the type of cement to be used, explain the basis for the selection, and describe the user verification testing to be performed.

11.3.2 Indicate the specifications to be used for the concrete aggregate, and indicate the quality control testing to be performed to assure the conformance to specifications of delivered aggregate. Similarly, indicate specifications and tests for the mixing water.

11.3.3 Describe the concrete mix procedures including extent of trial mix testing. Describe the type and usage of admixtures, their compliance with ASTM specifications, and extent of testing.

11.3.4 Indicate the extent to which splice stagger will be achieved.

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

11.3.6 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 biaxial 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.

11.3.7 Specify the proposed quality control procedures for the strength welds of reinforcing bars to structural elements such as plates, rings, sleeves, and for occasional strength weld splicing of heavy reinforcing bars.

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

11.3.9 Describe the prestressing materials and hardware selected. Justify the prestressing system selection. This should include data with regard to ultimate tendon strength, elongation, anchorage strength, hardware dynamic performance, conduits, etc.

11.4 Corrosion Protection

11.4.1 Describe the proposed concrete cover provisions for reinforcing steel for the dome, slab, and cylinder. Include the minimum ACI 318-63 code requirements for comparison.

11.4.2 Discuss the extent of consideration given to the need for cathodic protection. What protection will be provided? If soil resistivity surveys have been conducted, report the results.

11.4.3 Discuss the extent to which protective coatings will be applied to the liner.

11.4.4 Discuss the corrosion protection system for the prestressing system.

11.4.5 Refer to item 11.2.2 above which notes lack of a layer of porous concrete between the soil and the containment. Justify the omission of such drainage provisions. Especially consider the fact that the containment structure is continuously subjected to thermal gradients. These generate tensile stresses in the outside concrete layers which increase the likelihood of cracking, thus opening paths for water entrance.

11.5 Construction

11.5.1 In regard to the codes of practice that will be followed in the containment construction as listed on page 5-47 of the PSAR:

(a) Indicate where and to what extent ACI 301 standard practice for construction will be equaled, exceeded, or not followed.

(b) Indicate the specific extent to which ASME fabrication standards will be adhered to in liner manufacturing.

(c) Supplement the listing 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.

11.5.2 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.

11.5.3 Based on the preliminary construction schedule, describe in some detail the general procedures and sequence of events applicable to construction of the containment. Include excavation, ground water control, base slab construction, liner erection and testing, concrete construction in cylinder and dome regions, prestressing systems erection and prestressing sequence.

11.5.4 Provide a detailed description of the proposed erection of the bottom liner. Show how a good bearing of the liner on the concrete below will be ensured. State if grouting is to be used and indicate how the liner plates will be fitted to the embedded anchors.

11.5.5 Describe the concrete placing and curing procedures.

11.5.6 Describe the procedure for bonding between concrete lifts and indicate the manner in which the lifts will be placed and staggered.

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

11.5.8 Describe the extent of concrete compression and slump testing to be used. Include the statistical basis for the proposed program and the standards for rejection and pour removal.

11.5.9 Indicate the planned program of user testing of reinforcing steel for strength and ductility. Include the statistical basis for the program and the basis for reinforcing steel shipment rejection.

11.5.10 Indicate the controls that will be provided to ensure that the properly specified reinforcing bars are received, and, if different grades of steel are used, how mistakes will be avoided during erection.

11.5.11 Indicate the Cadweld splice procedures that will be used, including operator qualification procedures to be followed, inspection and testing, and standards for rejection.

11.5.12 Indicate the minimum percentage of Cadweld splices to be tested. A tolerance limiting the offset of two bars to be spliced should be provided.

11.5.13 Describe the reinforcing bar welding procedures and quality control to be used in performing reinforcing bar strength welds. Include bar preparation, user verification testing of reinforcing steel composition, maximum permissible alloy specifications, temperature control provisions, radiographic and strength testing requirements, and the basis for welded splice rejection and cut-out. State whether any tack welding of reinforcing steel will be permitted.

11.5.14 Indicate the minimum percentage of reinforcing splices to be checked by the welding inspector, using nondestructive inspection methods (X-raying, dye penetrant test, etc.).

11.5.15 Indicate the controls to be employed in reference to liner plate out-of-roundness and local bulges.

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

11.5.17 Indicate the applicable ASME or API code sections that will be adhered to in liner erection.

11.5.18 Indicate the procedures and criteria for control of seam weld porosity.

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

11.5.20 Discuss the seam weld radiography program. Also, provide an evaluation of the proposed liner radiography program to provide assurance that flaws capable of developing into positive leakage paths under design basis accident conditions will not, in fact, exist.

11.5.21 Describe the quality control procedures for liner angle and stud welding.

11.5.22 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.

11.5.23 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.

11.5.24 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.

11.5.25 Describe the extent of testing of the tendon corrosion-inhibiting wax or grease to insure the absence of substances harmful to the tendons.

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

11.6 <u>Construction Inspection</u>

11.6.1 Indicate the degree to which material preparation and construction activities will be subject to inspector surveillance.

11.6.2 Discuss the manner in which records of quality control and inspection will be kept during construction.

11.7 <u>Testing and In-Service Surveillance</u>

11.7.1 Describe the sequence for structural testing.

11.7.2 Describe the instrumentation program for structural testing. Include:

(a) Identification of structural, and liner areas to be instrumented.

(b) Purpose, type, expected accuracy, and redundancy of instrumentation.

(c) The range of strains and deformations expected.

(d) The protective measures that will be taken to insure instrument performance during structural testing, considering the interval between instrument installation and its use.

11.7.3 Evaluate the extent to which the test pressure will simulate design basis accident conditions by comparing the stresses under various test pressures with those in the structure under: (a) accident pressure plus temperature gradient, and (b) accident pressure plus temperature gradient, plus earthquake (or other combinations, if governing), for the following structural elements: (1) circumferential reinforcing and prestressing; (2) axial (longitudinal) reinforcing and prestressing; (3) dome reinforcing and prestressing; (4) base slab reinforcing; and (5) large openings. Indicate corresponding concrete stresses.

11.7.4 By comparing stresses and strains which are experienced by the structural elements under test loadings with those calculated to exist under design basis accident loading, provide a discussion in support of the selected test pressures. Include in this discussion the extent to which increased test pressure or design modifications might obtain closer test verification of structural integrity.

11.7.5 Provide a table that compares the computed stresses for two different pressure test condtions 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.

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

11.7.7 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.

11.7.8 Explain whether it is intended to measure stresses at different points in concrete and reinforcing steel, especially in ring girders at main openings and in the discontinuity zones.

11.7.9 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.

REQUEST FOR INFORMATION - SUPPLEMENT NO. 2

ARKANSAS POWER AND LIGHT COMPANY

Docket No. 50-313

12. FLOOD, TORNADO AND EARTHQUAKE RELATED FACTORS

12.1 Flooding. Provide additional information on the possible effects on structures, systems and equipment in the event that flooding at the site should occur:

a. Adequacy of design of water intake structures, particularly with reference to elevation of pumps and trash screens in relation to flood levels.

b. Adequacy of design of buildings of the nuclear facility, including the auxiliary buildings.

c. Protection afforded systems required for safe shutdown to assure their continued availability.

d. Location and nature of design of all flood protection features available or to be added to the plant site, such as dikes. Relate the heights of these features to expected flood heights.

12.2 Tornado Loading. On p[illegible] of the PSAR it is noted that the design will be made for tornado loads possessing a peripheral tangential velocity of 300 mph and a forward progression of 40 mph. Clarification is required as to the basis of the selection of the 40 mph forward progression velocity since this is somewhat less than the forward progression velocity often associated with tornado loading criteria.

12.3 Earthquakes

12.3.1 In addition to the containment building crane, which is listed as a Class I item, information is requested as to the design of the other facility cranes to insure that they cannot be dislodged during an earthquake or otherwise cause damage which might impair safe shutdown and containment.

12.3.2 It is noted on page 5-A-4 of Appendix 5A that Class II structures will be designed in accordance with the Uniform Building Code. Clarification is required as to the applicable zone for which the design is to be made.

12.3.3 The design of the equipment hatches is described on page 5-34 and Figure 5-3 of the PSAR. Additional information is requested as to the nature of the personnel locks and the design criteria that will be employed to insure that the seismic loading of these locks will not lead to difficulties with containment.

12.3.4 With regard to the damping values to be employed in the seismic analysis, the table on page 5-A-5 of the PSAR does not include damping for rocking motion of the containment structure on its foundation. If rocking is to be included in the analysis, a statement as to the amount of damping to be permitted for this mode of motion for both the design and maximum earthquake is requested.

12.3.5 The method of dynamic analysis described on pages 5-31 and 5-32 of the PSAR indicates that the response of the modes of vibration will be combined on a root-mean-square basis to obtain the most probable value of the maximum response. This approach is generally satisfactory if the number of included modes is sufficient; however, for a small number of modes it is often appropriate to add the maxima directly. Information is requested as to the number of modes that will be included for this analysis.

12.3.6 No mention is noted in the PSAR as to the method by which the vertical and horizontal earthquake stresses will be combined with other applicable stresses arising from operating loads, live loads, etc. It is customary for the vertical and horizontal earthquake stresses to be combined directly and linearly with the other applicable stresses. Clarification of the manner in which the stresses will be combined is requested.

12.3.7 With regard to the design of the containment structure and associated structures nearby, indicate the maximum expected values of relative displacement in any direction that might occur during seismic or static loading. State what provisions are incorporated into the design to handle these relative motions.

13. STRUCTURAL DESIGN

13.1 On pages 5-16 and 5-17 are described the two design approaches that are to be employed, namely the design load approach involving "working stress" design, and the approach involving factored loads. In the first case the forces will be compared with code stresses except for certain exceptions which have been described in immediately preceding sections. However, it is noted that the design load approach does not include a combination involving earthquake, pipe rupture, etc. The factored load approach involves a quite different set of load combinations which are compared with the yield strength of the structure.

In this case the loading combinations include the design and maximum earthquake loadings, pipe rupture, etc. Indicate whether the factored load analysis approach is to provide any check against the design load approach. It is hard to visualize how such a check can be meaningful since the same loadings are not considered in the two cases; clarification of this point is requested.

Also, information is requested as to the basis for evaluating the margin of safety from both design approaches in terms of design comparison. Stated another way, indicate under what conditions is it decided that one or the other design approach is to control the design.

13.2 Refer to the load combinations (a) through (f) on page 5-18. Compare combinations (e) and (f) with (a) through (d) and indicate under which conditions, or at what locations, it is expected that loading conditions in (e) and (f) will control the design. Combination (e) appears to contain an error. Clarification is requested.

13.3 In the discussion of the stress criteria associated with the factored load approach and particularly that presented in paragraphs 3, 4, and 5 on page 5-19, it is noted that the steel will be allowed to attain but not exceed yield, the concrete will be allowed to approach 0.85 f_c', yet no redistribution of stress will be allowed beyond yield, and yet again the liner strains will be limited to 0.005 inches per inch. The approach of not permitting the factored load design to exceed yield appears satisfactory. However, in view of the slight difference in the criteria that are presented, clarification is requested as to how the limitation on liner strain compares with limiting the reinforcing steel and concrete to yield without subsequent deformation. The liner strain value would suggest significant deformation beyond yield.

Moreover, clarification is requested as to whether limitation on liner strain is a general membrane strain in the liner or whether it corresponds to localized yielding around penetrations, etc.

With regard to the reinforcing steel, it is indicated in paragraph 4 on page 5-19 that the reinforcing steel forming the load carrying system will not be allowed to go beyond yield. Paragraph 5 states that nonprestressed reinforcing steel would be allowed to exceed yield. Specific comment on this particular situation is requested.

13.4 On page 5-24 the liner plate anchor spacing and thickness is described to be such that the critical buckling stress of the liner will be higher than the proportional limit. Additional information on the design of the liner against buckling is requested. Include an indication of the boundary conditions assumed for liner buckling, the buckling stress and the approach used in calculating it, and detailed information concerning the method of attachment of the liner to the anchors.