SEP 16 1981

Docket Nos. 50-440
and 50-441

RECEIVED SEP 17 1981 U.S. NUCLEAR REGULATORY COMMISSION

Mr. Dalwyn R. Davidson
Vice President - Engineering
Cleveland Electric Illuminating
Company
P. O. Box 5000
Cleveland, Ohio 44101

Dear Mr. Davidson:

Subject: Request For Additional Information - Structural Engineering

In the performance of the Perry licensing review, the staff has identified concerns in regard to structural engineering. The information that we require is identified in the enclosure.

We request that you provide the information not later than October 30, 1981. If you require any clarification of this request, please contact me at (301) 492-8593.

Sincerely,

M. Dean Houston, Project Manager
Licensing Branch No. 2
Division of Licensing

Enclosure:
Request for Additional Information

cc w/enclosure:
See next page

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NRC FORM 318 (10-80) NRCM 0240 OFFICIAL RECORD COPY USGPO: 1981—335-960

Mr. Dalwyn R. Davidson
Vice President, Engineering
The Cleveland Electric Illuminating Company
P. O. Box 5000
Cleveland, Ohio 44101

cc: Gerald Charnoff, Esq.
Shaw, Pittman, Potts & Trowbridge
1800 M Street, N. W.
Washington, D. C. 20006

Donald H. Hauser, Esq.
The Cleveland Electric Illuminating Company
P. O. Box 5000
Cleveland, Ohio 44101

Resident Inspector's Office
U.S.N.R.C.
Parmly at Center Road
Perry, Ohio 44081

Donald T. Ezzone, Esq.
Assistant Prosecuting Attorney
105 Main Street
Lake County Administration Center
Painesville, Ohio 44077

Tod J. Kenney
228 South College, Apt. A
Bowling Green, Ohio 43402

Daniel D. Wilt
Wegman, Hesiler & Vanderberg
7301 Chippewa Road, Suite 102
Brecksville, Ohio 44141

Robert Alexander
OCRE Interim Representative
2030 Portsmouth Street
Suite 2
Houston Texas 77098

Terry Lodge, Esq.
915 Spitzer Building
Toledo, Ohio 43604

REQUEST FOR ADDITIONAL INFORMATION

STRUCTURAL ENGINEERING BRANCH

PERRY NUCLEAR POWER PLANT UNITS 1 AND 2

DOCKET NUMBERS: 50-440/441

220.06 (3.3.2) Provide procedures by which venting, if considered, is used to reduce the tornado vacuum in your Category I structural design.

220.07 (3.5.3) In your barrier design procedures there is not enough information in the evaluation of overall response of structural elements subjected to impactive or impulsive load, such as impacts due to missiles. A copy of the draft Appendix A to Standard Review Plan (SRP) Section 3.5.3 is attached herewith for your reference (Attachment 1). Please take notice of the staff position on the acceptable ductility ratios for reinforced concrete and structural steel elements subjected to impactive and impulsive loads. Express your intention to comply with this staff position.

220.08 (3.7.1) You stated that for the dynamic analysis used in this plant, the hysteretic damping in combination with small percentage theoretical viscous damping is used as a conservative approach. Please explain in detail and discuss the technical basis for the assessment of the conservatism of the approach.

220.09 (3.7.1) Demonstrate that the frequency intervals at which spectra values are calculated from the design time history are smal enough that any reduction in these intervals does not result in more than 10% change in the computed values.

220.10 (3.7.1) With regard to the issue of interaction of non-Category I structures with seismic Category I structures, discuss the basis for the selection of the three inches structural gap. Also list the analytical results (displacement) and demonstrate that adequate separation among structures has been provided.

220.11 (3.7.2) With respect to FSAR Section 3.7.2.1 seismic analysis method, you didn't state clearly how many significant modes were included in the modal analysis. It is the staff's position that a sufficient number of modes should be considered; the criterion for sufficiency is that the inclusion of additional modes does not result in more than 10% increase in response. Please indicate your compliance with this position or justify any deviation from the position.

220.12 (3.7.2) With respect to Section 3.7.2.4 soil-structure interaction analysis for diesel generator building and off-gas building, you stated that finite element method was used. It is the staff's position that modeling methods for implementing the soil-structure interaction analysis should include both the half-space and finite element approaches. Category I structures, systems and components supported on soil should be designed to accommodate responses obtained by one of the following: (a) envelope of results of the two methods, (b) results of one method with conservative design considerations of effects from use of the other method, and (c) combination of (a) and (b) with provision of adequate conservatism in design. Express your intention to comply with this staff position.

220.13 (3.7.3) With respect to FSAR Section 3.7.3.9.1 you stated that equipment supported at different locations is analyzed by imposing a single conservative response spectrum at each location, this response spectrum is considered in such a way that it conservatively envelopes the pertinent response spectra of the different locations. Please provide more details and give an example of how the relative displacement between supports are generated and used in the static analysis of systems with differential support motion.

220.14 (3.8.1) With respect to FSAR Table 3.8.1, please provide in a tabular format the design moments, shears and the required reinforcements corresponding to various governing load combinations for:

(1) Shield building cylinder wall ring girder at the junction of dome.

(2) Shield building cylinder wall at the junction of foundation mat.

220.15 (3.8.1) With respect to FSAR Section 3.8.1.1, description of the containment (shielding building, p. 3.8-4) you stated that typical details of the cylinder wall foundation mat junction are shown in Figure 3.8.-3. The title and content of Figure 3.8.-3 show the typical reinforced section for the shield building wall and dome. Please correct the discrepancy.

220.16 (3.8.1, 3.8.3 3.8.4 and 3.8.5) With reference to FSAR Section 3.8.1.2, 3.8.3.2, 3.8.4.2 and 3.8.5.2, applicable codes, standards and specifications, it is the staff's position that ACI 349-76 Code should be used in conjunction with Regulatory Guide (R.G.) 1.142. Identify deviations of Category I structural design from the requirements of the code and the Regulatory Guide and justify your deviations.

220.17 (3.8.2) With respect to FSAR Table 3.8.2, provide in a tabular format the stresses corresponding to various governing loading combinations for the steel vessel at key locations, such as:

(1) At the junction of steel shell and foundation mat.

(2) At the junction of steel shell and dome.

(3) At the junction of steel shell and polar crane support.

Also show that the design stresses at these points comply with the requirements of the ASME Section III, Division I Code.

220.18 (3.8.2) With respect to FSAR Section 3.8.2.4, design and analysis procedures, you stated that the buckling investigation of the containment vessel cylinder consists of two approaches. First the shell and stiffeners are verified to be in compliance with all the requirements of subsection NE-3133 of ASME Code, Section III and secondly, a detailed buckling analysis is performed using equations from "Structural Analysis of Shells". Please indicate:

(1) Your rationale for using the method of analysis from reference 9, of Section 3.8 of FSAR.

(2) The loads and load combinations that have the potential of buckling the containment vessel and how each load or load combination is applied to the vessel. The method given in Section 5 of the NUREG/CR 0793 report "Buckling Criteria and Application of Criteria to Design of Steel Containment Shell," is recommended for the analysis. Discuss, if applicable, the difficulties or problems which you may encounter in using the method. A comparison between the method that you used and the one recommended in NUREG/CR 0793 should be made to indicate that your method is conservative.

220.19 (3.8.2) Provide a containment capacity analysis of the steel containment responding to the internal pressure build up due to hydrogen burning. The guideline and staff position on this subject is enclosed (Attachment 2).

220.20 (3.8.2) (3.8.3) With reference to the issue of fluid/structure interaction, you stated, in Section 2.1.4, Appendix 3A of FSAR, that for fluid modeling three different modeling techniques were used to represent the water, and ANSYS Computer Program was used for all three analyses. You concluded the concentrated mass method adequately represented the fluid and is used in the reactor building analysis. Discuss in detail of your technical basis for the conclusion and provide the results of the hydrodynamic loads analysis.

220.21 (3.8.2) (3.8.3) With respect to the loads and load combinations for steel containment vessel (Section 3.8.2.3), steel and concrete internal structures (Section 3.8.3.3), a load summation method for static and dynamic loads due to pool swell and safety relief valve discharge is recommended in Section 3BA.8.4, Appendix 3B of FSAR. Discuss the relative degree of conservatism between the use of the absolute sum method and that of the AC/DC method proposed. For your information, presently, the absolute sum method (ABS) of combining dynamic loads is acceptable to the staff.

220.22 (3.8.3) (1) Provide the analysis details of the lower region of drywell wall with regard to transfer of shear force to the foundation mat and the anchorage provision for uplift force.

(2) Provide design details for the drywell wall at main steam line whip restrains.

220.23 (3.8.3) With respect to FSAR Section 3.8.4.4 Design Methods of Drywell Wall, you stated that the drywell wall diagonal reinforcement was designed to the criteria for tangential shear requirement of ASME Code, Section III, Division 2. Provide design and analysis details to support your statement. Refer to SRP Section 3.8.1, II-4 for the exceptions taken by the staff, indicate your compliance with the staff's position, or justify any deviation from the position.

220.24 (3.8.4) With respect to FSAR Section 3.8.4.1.3, Fuel Handling Building, discuss, in detail, the design of spent fuel pool racks. Enclosed is a copy of staff position on "The minimum requirements for design of spent fuel pool racks" (Attachment 3). Modify your analysis and design, if necessary, to agree with this position.

220.25 (3.8.5) (1) With respect to the design and analysis of reactor building mat, please provide your analysis results such as the design moments and shears for the foundation mat at various critical sections. Provide a detailed discussion of how these moments and shears are accommodated in the design.

(2) Provide design calculations of reactor building foundation mat reinforcement at the junction of:

(a) Concrete shield building wall;

(b) Drywell wall; and

(c) Reactor pressure vessel pedestal wall.

(3) Demonstrate that applicable code provisions are fully met in your design.

220.26 (3.8.5) Provide detail stability analysis of Category I structures and demonstrate that the factors of safety against floating, sliding and overturning as shown in SRP Section 3.8.5 II-5 are met.

220.27 (3.8.5) With respect to FSAR Section 3.8.5.1, you stated that where possible shear transfer from the bearing material to the reinforced concrete foundation is by frictions, otherwise shear transfer is by a combination of friction and passive soil pressure against shear keys. Provide the shear key design analysis for auxiliary building, fuel handling building, control building, intermediate building and the off-gas building.

220.28 (3.8.5) With respect to FSAR Section 3.8.5.5, p. 3.8-209 the expression $30f'c$ should be $30\sqrt{f'c}$ please correct the error.

220.29 Prepare for the structural design audit scheduled for the week of November 23, 1981. A copy of requirements for implementation of structural design audits is enclosed (Attachment 4). The audit guidelines will be sent to you by September 28, 1981. You are requested to fill in the audit guidelines prior to the audit meeting in order to expedite the audit work.

ATTACHMENT 1

APPENDIX A TO SRP SECTION 3.5.3

ALLOWABLE DUCTIILITY RATIO

FOR OVERALL DAMAGE PREDICTION

I. INTRODUCTION

In the evaluation of overall response of reinforced concrete structural elements (e.g., missile barriers, columns, slabs, ets.) subjected to impactive or impulsive loads, such as impacts due to missiles, assumption on non-linear response (i.e. ductility ratios greater than unity) of the structural elements is generally acceptable provided that the intended safety functions of the structural elements and those of safety-related systems and components supported or protected by the elements are maintained. The following summarizes specific positions and review and acceptance of ductility ratios for reinforced concrete and steel structural elements subjected to impactive and impulsive loads.

II. SPECIFIC POSITIONS

1. REINFORCED CONCRETE MEMBERS

a. For beams, slabs, and walls where flexure controls design, the permissible ductility ratio under impactive and impulsive loads should be taken as $\frac{0.05}{p-p} \leq 10$ where p and p' are the ratios of tensile and compressive reinforcing as defined in ACI 349-76 Code.

b. If use of ductility ratio greater than 10 (i.e., $\mu > 10$) is required to demonstrate design adequacy of structural elements against impactive or implusive loads, e.g., missile impact, such as usage should be identified and justified by submittal of applicable experimental evidence in the plant SAR.

c. For beam-columns, walls, and slabs carrying axial compression loads and subject to impactive loads (e.g., missile impact) producing flexure, the permissible ductility ratio in flexure should be as follows:

(i) When compression controls the design, as defined by an interaction diagram, the permissible ductility ratio μ should be 1.3.

(ii) When the compression load does not exceed $0.1f'_cA_g$ or one-third of that which would produce balanced conditions, whichever is smaller, the permissible ductility ratio μ should be as given in 1.a.

(iii) The permissible ductility ratio should vary linearly from 1.3 to that given in 1.a for conditions between those specified in (i) and (ii) (see Fig. 1).

d. For beam-columns, walls, and slabs, carrying axial compression loads subject to implusive loads (e.g., compartment pressurization) producing flexure, the permissible ductility ratio μ in flexure should be 1.0.

e. For structural elements resisting axial compressive impulsive or impactive loads only, without flexure, the permissible axial ductility ratio μ should be 1.3.

f. For shear carried by concrete only

$\mu = 1.0$

For shear carried by concrete and stirrups or bent bars

$\mu = 1.3$

For shear carried entirely be stirrups

$\mu = 3.0$

2. STRUCTURAL STEEL MEMBERS

a. For tension due to flexure

$\mu = 10.$

b. For columns with slenderness ratio (ℓ/r) equal or less than 20

$\mu = 1.3$

Where ℓ = effective length of the member

r = the least radius of gyration

For columns with slenderness ratio greater than 20

$\mu = 1.0$

c. For members subjected to tension

$$\mu = 0.5 \frac{\varepsilon u}{\varepsilon y}$$

Where εu = ultimate strain

εy = yield strain

ATTACHMENT 2

CAPACITY ASSESSMENT OF STEEL CONTAINMENT

The analysis should be performed to provide a reasonable assurance that the integrity of the containment will be maintained during an accident that releases hydrogen generated from 75% fuel clad metal-water reaction accompanied by either hydrogen burning or the added pressure from post-accident inerting assuming carbon dioxide is the inerting agent, depending upon which option is chosed for control of hydrogen.

As a criterion of such an assurance, it should be demonstrated through an analysis that in case of an accident described above, the requirements of the ASME Boiler and Pressure Vessel Code, Division 1, (Code) Subsubarticle NE-3220, Service level C Limits, considering pressure and dead load alone, will be met.

As a minimum, the code requirements set above should be met for a combination of dead load and an internal pressure of 45 psig.

If the option chosen for hydrogen control is post-accident inerting, the following must be demonstrated by the analysis:

(a) Containment structure loading produced by an inadvertent full inerting (assuming carbon dioxide), but not including seismic or design basis accident loading will not produce stresses in steel containment in excess of the limits set forth in the ASME Boiler and Pressure Vessel Code, Division 1, Subsubarticle NE-3220, Service level A Limits, except that evaluation of instability is not required.

(b) A pressure test, which is required, of the contai.ments 1.10 times the pressure calculated to result from carbon dioxide inerting can be safely conducted, and,

(c) In advertent full inerting of the containment can be safely accommodated during plant operation.

In order to be acceptable, the analysis used for determination of ultimate capacity of the containment should be based on the general principles of structural mechanics and consistent with sound engineering practices. The model used in the analysis should be realistic representation of the containment structure.

The pressure capacity of localized areas as well as of the overall containment structure should be examined for the static and dynamic pressures respectively. The static and dynamic pressures to be used in the analysis should be approved by the Containment Systems Branch.

The analysis should be made on the basis of the allowables specified in the Code. However, if the actual material properties, such as the tested material strength, strength variations indicatd by mill test certificates and other material uncertainities are available, the lower and upper bounds of the cortainment capacity may be established statistically. The details of the analysis and the results should be submitted in a report form with the following identifiable information.

1. The original design pressure, Pa, as defined in the Code, Subsubarticle NE-3220;
2. Calculated static pressure capacity;

3. Equivalent static pressure response calculated from dynamic pressure;
4. The associated failure mode;
5. The criteria governing the original design and the criteria used to establish failure;
6. Analysis details and general results; and,
7. Appropriate engineering drawings adequate to allow verification of modeling and evaluation of analyses employed for the containment structure.

ATTACHMENT 3

APPENDIX D TO SRP SECTION 3.8.4

MINIMUM REQUIREMENTS FOR DESIGN OF SPENT FUEL POOL RACKS

INTRODUCTION

The purpose of this appendix is to provide the minimum requirements and criteria for review of spent fuel pool racks. The criteria for the structural design of the spent fuel pool proper are contained in the main body of this section. This appendix describes the acceptable criteria of the spent fuel pool structure as it relates to the racks.

(1) Description of the Spent Fuel Pool and Racks

Descriptive information including plans and sections showing the spent fuel pool in relation to other plant structures shall be provided in order to define the primary structural aspects and elements relied upon to perform the safety-related functions of the pool, spent fuel pool liner and the racks. The main safety function of the spent fuel pool, the liner and the racks is to maintain the spent fuel assemblies in a safe configuration through all environmental and abnormal loadings, such as earthquake, and impact due to spent fuel cask drop, drop of a spent fuel assembly or drop of any other heavy object during routine spent fuel handling.

The major structural elements reviewed and the extent of the descriptive information required are indicated below.

(a) Support of the Spent Fuel Racks: The general arrangements and principal features of the horizontal and the vertical supports to the spent fuel racks should be provided indicating the methods of transferring the loads on the racks to the fuel pool wall and the foundation slab. All gaps (clearance or expansion allowance) and sliding contacts should be indicated. The extent of interfacing between the new rack system and the old fuel pool walls and base slab should be discussed, i.e., interface loads, response spectra, etc.

If connections of the racks are made to the base and to the side walls of the pool such that the pool liner may be perforated, the provisions for avoiding leakage of radioactive water of the pool should be indicated.

(b) Fuel Handling: Postulation of a drop accident, and quantification of the drop parameters are reviewed by the Accident Evaluation Branch (AEB). Structural Engineering Branch accepts the findings of the AEB review for the purpose of review of integrity of the racks and the fuel pool including the fuel pool liner due to a postulated fuel handling accident. Sketches and sufficient details of the fuel handling system should be provided to facilitate this review.

(2) Applicable Codes, Standards and Specifications

Construction materials should conform to Section III, Subsection NF of Reference 3.1. All materials should be selected to be compatible with the fuel pool environment to minimize corrosion and galvanic effects.

Design, fabrication, and installation of spent fuel racks of stainless steel material may be performed based upon Subsection NF requirements of Reference 3.1 for Class 3 component supports.

(3) Seismic and Impact Loads

For plants where dynamic input data such as floor response spectra or ground response spectra are not available, necessary dynamic analyses may be performed using the criteria described in Section 3.7 of this plan. The ground response spectra and damping values should correspond to R. G. 1.60 and 1.61 respectively. For plants where dynamic data are available, e.g., ground response spectra for a fuel pool supported by the ground, floor response spectra for fuel pools supported on soil where soil-structure interaction was considered in the pool design or a floor response spectra for a fuel pool supported by the reactor building, the design and analysis of the new rack system may be performed by using either the existing input parameters including the old damping values or new parameters in accordance with R. G. 1.60 and 1.61. The use of existing input with new damping values in R. G. 1.61 is not acceptable.

Seismic excitation along three orthogonal directions should be imposed simultaneously for the design of the new rack system. The peak response from each direction should be combined by square root of the sum of the squares in accordance with R. G. 1.92. If response spectra are available for a vertical and horizontal directions only, the same horizontal response spectra may be applied along the other horizontal directions.

Submergence in water should be taken into account. The effects of submergence are considered on case-by-case basis.

Due to gaps between fuel assemblies and the walls of the guide tubes, additional loads will be generated by the impact of fuel assemblies during a postulated seismic excitation. Additional loads due to this impact effect may be determined by estimating the kinetic energy of the fuel assembly. The maximum velocity of the fuel assembly may be estimated to be the spectral velocity associated with the natural frequency of the submerged fuel assembly. Loads thus generated should be considered for local as well as overall effects on the walls of the rack and the supporting framework. It should be demonstrated that the consequent loads on the fuel assembly do not lead to a damage of the fuel.

Loads generated from other postulated impact events may be acceptable, if the following parameters are described: the total mass of the impacting missile, the maximum velocity at the time of impact, and the ductility ratio of the target material utilized to absorb the kinetic energy.

(4) Loads and Load Combinations

Any change in the temperature distribution due to the proposed modification should be identified. Information pertaining to the applicable design loads and various combinations thereof should be provided indicating the thermal load due to the effect of the maximum temperature distribution through the pool walls and base slab. Temperature gradient across the rack structure due to differential heating effect between a full and an empty cell should be indicated and incorporated in the design of the rack structure. Maximum uplift forces available from the crane should be indicated including the consideration of these forces in the design of the racks and the analysis of the existing pool floor, if applicable.

The fuel pool racks, the fuel pool structure, including the pool slab and fuel pool liner, should be evaluated for the accident load combinations which include the impact of the spent fuel cask, the heaviest, postulated load drop, and/or accidental drop of fuel assembly from maximum height as described in paragraph (1) a. The acceptable limits (strain or stress limits) in this case will be reviewed on a case by case basis but, in general, the applicant is required to demonstrate that the functional capability and/or the structural integrity of each component is maintained.

The specific loads and load combinations are acceptable if they are in conformance with the applicable portions of Section 3.8.4-II.3 of this plan and Table 1.

(5) Design and Analysis Procedures

Details of the mathematical model including a description of how the important parameters are obtained should be provided including the following: the methods used to incorporate any gaps between the support systems and gaps between the fuel bundles and the guide tubes; the methods used to lump the masses of the fuel bundles and the guide tubes; the methods used to account for the effect of sloshing water on the pool walls; and, the effect of submergence on the mass, the mass distribution and the effective damping of the fuel bundle and the fuel racks.

The design and analysis procedures in accordance with Section 3.8.4-II.4 of this plan are acceptable. The effect on gaps, sloshing water, and increase of effective mass and damping due to submergence in water should be quantified.

When pool walls are utilized to provide lateral restraint at higher elevations, a determination of the flexibility of the pool walls and the capability of the walls to sustain such loads should be provided. If the pool walls are flexible (having a fundamental frequency less than 33 hertz), the floor response spectra corresponding to the lateral restraint point at the higher elevation are likely to be greater than those at the base of the pool. In such a case using the response spectrum approach, two separate analyses should be performed as indicated below:

(a) A spectrum analysis of the rack system using response spectra corresponding to the highest support elevation provided that there is not significant peak frequency shift between the response spectra at the lower and higher elevations; and,

(b) A static analysis of the rack system by subjecting it to the maximum relative support displacement.

The resulting stresses from the two analyses above should be combined by the absolute sum method.

In order to determine the flexibility of the pool wall it is acceptable for the applicant to use equivalent mass and stiffness properties obtained from calculations similar to those described in Reference 4.1. Should the fundamental frequency of the pool wall model be higher than or equal to 33 hertz, it may be assumed that the response of the pool wall and the corresponding lateral support to the new rack system are identical to those of the base slab, for which appropriate floor response spectra or ground response spectra may already exist.

(6) Structural Acceptance Criteria

When subsection NF, Reference 3.1 is used for the racks, the structural acceptance criteria are those given in the Table 1. When buckling loads are considered in the design, the structural acceptance criteria shall be limited by the requirements of Appendix XVII to Reference 3.1.

For impact loading the ductility ratios utilized to absorb kinetic energy in the tensile, flexural, compressive, and shearing modes should be quantified. When considering the effects of seismic loads, factors of safety against gross sliding and overturning of racks and rack modules under all probable service conditions shall be in accordance with the Section 3.8.5. II-5 of this plan. This position on factors of safety against sliding and tilting need not be met provided any one of the following conditions is met:

(a) it can be shown by detailed nonlinear dynamic analyses that the amplitudes of sliding motion are minimal, and impact between adjacent rack modules or between a rack module and the pool walls is prevented provided that the factors of safety against tilting are within the values permitted by Section 3.8.5.II.5 of this plan.

(b) it can be shown that any sliding and tilting motion will be contained within suitable geometric constraints such as thermal clearances, and that any impact due to the clearances is incorporated. The fuel pool structure should be designed for the increased loads due to the new and/or expanded high density racks. The fuel pool liner leak tight integrity should be maintained or the functional capability of the fuel pool should be demonstrated.

(7) <u>Materials, Quality Control, and Special Construction Techniques:</u> The materials, quality control procedures, and any special construction techniques should be described. The sequence of installation of the new fuel racks, and a description of the precautions to be taken to prevent damage to the stored fuel during the construction phase should be provided.

If connections between the racks and the pool liner are made by welding, the welder as well as the welding procedure for the welding assembly shall be qualified in accordance with the applicable code.

TABLE 1

LOAD COMBINATION	ACCEPTANCE LIMIT
D + L D + L + To	level A service limits
D + L + To + E D + L + Ta + E D + L + To + Pf	level B service limits
D + L + Ta + E'	level D service limits
D + L + Fd	The functional capability of the fuel racks should be demonstrated
<u>Limit Analysis</u>	limits of Appendix XVII-4000 to ASME Code Section III, Division 1.
1.7 (D + L) 1.3 (D + L) + To)	
1.7 (D + L + E) 1.3 (D + L + E + To) 1.[illegible] (D + L + E + Ta) 1.[illegible] (D + L + To + Pf)	
1.1 (D + L + Ta + E')	

Notes: 1. The abbreviations in the table above are those used in Subsection II.3.a of where each term is defined except for Ta which is defined here as the highest temperature associated with the postulated abnormal design conditions.

2. Deformation limits specified by the design specification limits shall be satisfied, and such deformation limits should preclude damage to the assemblies.

3. The provision of NF 3231.1 of Reference 3.1 shall be amended by the requirements of the paragraphs c. 2, 3 and 4 of the R. G. 1.124 entitled "Design Limits and Load Combinations for Class 1 Linear-Type Component Supports."

4. Fd is the force caused by the accidental drop of the heaviest load from the maximum possible height and Pf is upward force on the racks caused by postulated structural fuel assembly.

REFERENCES

1. Regulatory Guides

1.29 - Seismic Design Classification

1.60 - Design Response Spectra for Seismic Design of Nuclear Power Plants

1.61 - Damping Values for Seismic Design of Nuclear Power Plants

1.76 - Design Basis Tornado for Nuclear Power Plants

1.92 - Combining Modal Responses and Spatial Components in Seismic Response Analysis

1.124 - Design Limits and Loading Combinations for Class 1 Linear-Type Components Supports

2. Standard Review Plan

3.7 - Seismic Design

3.8.4 - Other Category I Structures

3. Industry Codes and Standards

1. American Society of Mechanical Engineers, Boiler and Pressure Vessel Code, Section III, Division 1

2. American National Standards Institute, N210-76

3. American Society of Civil Engineers, Suggested Specification for Structures of Aluminium Alloys 6061-T6 and 6067-T6

4. The Aluminium Association, Specification for Alumnium Structures

Other

1. Biggs, John M., "Introduction to Structural Dynamics," McGraw-Hill Book Co., New York, 1964

ATTACHMENT 4

APPENDIX B TO SRP SECTION 3.8.4

STRUCTURAL DESIGN AUDITS

1. Introduction

Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants", to 10CRF50, "Licensing of Production and Utilization Facilities" requires, in part, that the design control measures shall provide for verifying or checking the adequacy or simplified calculational methods, or by the performance of a suitable testing program. This appendix provides requirements and guidelines for implementation of structural design audits.

2. Objectives

The audit is conducted in order that the following objectives are accomplished:

(a) To investigate in detail of the manner in which the applicant has implemented the structural design criteria that he committed to use for the facility.

(b) To verify that the key structural design calculations have been conducted in an acceptable way.

(c) To identify and assess the safety significance of these areas where the plant structures were designed and analyzed using methods other than those recommended by the NRC Standard Review Plan.

3. Preliminary Arrangements

Arrangements for the audit are to be made by the Licensing Project Manager (LPM). The audit agenda, including specific areas of interest are prepared by the reviewer and forwarded to the applicant at least thirty (30) days prior to the date of the audit. The LPM should notify the appropriate I&E regional office personnel as well as any intervening parties, if applicable, about the forthcoming audit.

4. Conduct of the Audit

(a) An Overview of the Plant Design:

The applicant should present an overview of each of the key structures including a brief description, assumptions, modeling techniques, and technique features of design as well as any deviations from those committed to in the SAR's.

(b) Audit of Design Calculations:

The auditing personnel review the design calculations for the structures which have been identified during the review of the applicant's Design Report. Any questions such as those regarding the structural modeling, analysis, proportioning of the members, and computer runs should be discussed among the participants in the audit and resolved. If such a resolution requires additional engineering data and further analysis on the part of the applicant the specific follow-up action items should be identified and noted in the meeting minutes for subsequent resolution.

5. Exit Meeting

An exit meeting is held at the conclusion of the audit to discuss and summarize the audit findings, generic issues pertaining to the design, specific action items, and the schedules for resolution of the action items.

6. Minutes of the Audit

The LPM is responsible for preparation of the audit minutes.

7. After-Audit Meetings

Review of the applicant's response to the action items may necessitate additional meeting(s) between the staff and the applicant to explain certain parts of the responses.

8. Input to the SER

The audit should be considered as an integral part of the review process. Resolution of the action items, together with appropriate consideration of other safety aspects should constitute the major basis for the staff's preparation of the SER.