(DRAFT)

TECHNICAL EVALUATION REPORT

SUPPLEMENTARY REPORT

REVIEW OF LICENSEE RESPONSE TO

DESIGN CODES, DESIGN CRITERIA, AND LOADING COMBINATIONS (SEP, III-7.B)

CONSUMERS POWER COMPANY

PALISADES PLANT

NRC DOCKET NO. 50-255

NRC TAC NO. 48726

NRC CONTRACT NO. NRC-03-81-130

FRC PROJECT C5506

FRC ASSIGNMENT 18

FRC TASK 422

Prepared by

Franklin Research Center
The Parkway at Twentieth Street
Philadelphia, PA 19103

Author: T. C. Stilwell, M. Darwish, E. W. Wallo

FRC Group Leader: T. C. Stilwell

Prepared for

Nuclear Regulatory Commission
Washington, D.C. 20555

Lead NRC Engineer: D. Persinko

October 10, 1983

Attachment 1

Franklin Research Center
A Division of The Franklin Institute
The Benjamin Franklin Parkway, Phila., Pa. 19103 (215) 448-1000

CONTENTS

CONTENTS (Cont.)

FOREWORD

This Technical Evaluation Report was prepared by Franklin Research Center under a contract with the U.S. Nuclear Regulatory Commission (Office of Nuclear Reactor Regulation, Division of Operating Reactors) for technical assistance in support of NRC operating reactor licensing actions. The technical evaluation was conducted in accordance with criteria established by the NRC.

1. INTRODUCTION

Current design criteria for nuclear power plant structures contain requirements that were not in effect when older plants were designed and licensed. Consequently, one aspect (designated Topic III-7.B) of the implementation of NRC's Systematic Evaluation Program requires licensees to review changes that have occurred in structural design criteria since their plant was built and also to review the loads and load combinations used for design of plant structures by comparing them with the loads and load combinations now specified for current construction. The licensee's objective is to assess the impact that these changes may have on margins of safety of Seismic Category I structures as they were originally perceived and as they would be perceived under current criteria. Upon completion of this work, licensees report their findings to the NRC.

To assist in this review, the NRC provided licensees with plant-specific Technical Evaluation Reports (TERs) concerning these issues (e.g., Reference 1). The TERs listed design code changes and, on a building-by-building basis, the load and loading combination changes to be addressed in the licensee review. The items listed were ones judged to have the greatest potential to degrade the originally perceived margins of safety.

In May 1983, under contract NRC-03-81-130, the NRC retained the Franklin Research Center (FRC) to assist in its review of licensee findings. This report describes the review for the Palisades Plant and summarizes Consumers Power Company's compliance status with respect to the implementation of SEP Topic III-7.B.

2. DESIGN CODE CHANGES DESIGNATED SCALE A

Current structural design codes contain provisions that differ from, or did not appear in, the codes to which older plants were designed and constructed. Changes that were judged to have the potential to significantly affect perceived margins of safety have been designated as Scale A. These changes are discussed item-by-item in this section of the report.

2.1 SHEAR CONNECTORS FOR COMPOSITE BEAMS

Four major modifications to the 1963 AISC Code [2] related to the type, distribution, and spacing of shear connectors for composite beams occur in the 1980 Code [3]. These modifications are:

a. Permission to use lightweight structural concrete (concrete made with C330 aggregates) in composite designs

b. Allowance of design for composite action in the negative moment region of continuous beams and provision of design guidance for including the longitudinal reinforcing steel in the negative moment resisting section

c. Design requirements for the minimum number of shear connectors in regions of concentrated load

d. Maximum and minimum spacing requirements in terms of stud diameters.

The first two modifications will not affect old designs because they were not allowed by the previous code. The new provisions concerning the number of studs in the region near concentrated loads and the new limits concerning spacing of studs may adversely affect the margin of safety in older designs when checked against the new code provisions. These new requirements are of special concern in the case of composite beams subject to large concentrated loads, such as those associated with extreme environmental or critical accident conditions.

2.2 COMPOSITE BEAMS OR GIRDERS WITH FORMED STEEL DECK

The 1980 AISC Code [3] contains a new section covering stay-in-place formed steel deck used in a composite design. These provisions for formed steel decking, depending on the rib geometry and the direction of the ribs relative to the beam, may affect the load capacity of the shear studs and the effective flange width of the assumed concrete compression flange. They provide for reduction factors, to be applied to the shear stud allowable capacity, which account for the structural irregularity introduced into the composite slab.

Composite beams with formed steel decks that were designed to the previous code could have less conservative margins of safety when compared to present requirements, especially in cases where extreme loadings are to be considered.

2.3 FLANGE STRESS IN HYBRID GIRDERS

The AISC Code section covering reduction of bending stress in the compression flange was modified in the 1980 Code.

The original flange stress reduction formula in the old code was needed to account for stress transfer which may occur in ordinary beam webs if the compression region should deflect laterally, thereby changing the bending capacity of the cross section. In hybrid girders, the amount of the loss of bending resistance resulting from this phenomenon will vary depending on the relative properties of the web and flange steel. A reduced bending stress formula reflecting this interaction was introduced. In order to keep the formulation relatively simple, the reduced bending stress was made applicable to both flanges of the hybrid member.

Beams or girders fabricated from plate and in which the flange and web steels are different could have lower margins of safety under the new code than were thought to exist under older requirements, in particular when the ratio of web yield stress to flange yield stress is less than 0.45 and the ratio of the web area to flange area is low.

2.4 STRESSES IN UNSTIFFENED COMPRESSION ELEMENTS

New requirements provide stress reduction factors for unstiffened elements subject to compression with one edge, parallel to the compressive stress, free.

Previous code provisions allowed the designer to neglect a portion of the area of such elements. The new code requirements provide equations for various elements based on the critical buckling stress for plates. The new analytical approach is more conservative for the stems of tees and less conservative for all other cases.

Where structural tees are used as main members and the tee stem is in compression, the margin of safety for older designs checked under the new code could be significantly less than was thought under prior code requirements. Since buckling is a non-ductile type failure, these new requirements are of special concern in the case of tee shapes subjected to the extreme environmental or critical accident conditions.

2.5 MAXIMUM LOAD IN RIVETED OR BOLTED TENSILE MEMBERS

The 1980 AISC Code [3] introduces codes changes which affect the maximum load permitted in tensile members.

Two interacting code changes are involved in establishing this limit, and the mutual effects of both must be considered in assessing the impact of the new code upon the perception of margins of safety in tension members. The two provisions involved concern:

1. the tensile area permitted to be used in establishing load carrying capacities
2. the allowable stresses to be used in conjunction with these areas.

Both effects are taken into account in ranking this change. The potential magnitude of the mutual effects of the two changes is discussed below.

The 1980 AISC Specification definition of "Effective Net Area" introduces a reduction coefficient which is to be applied to the traditional definition of net area. This essentially changes the design capacity of a tension member when compared to older versions of these specifications. First, consider only the effect of the critical area used for the design of a tension member as defined in the new code compared to the critical area used for the design of the same member as defined in the old code. Clearly, if all other factors are equal, the new code is more conservative. However, all other factors are not the same. The changes in allowable tensile stress definition (on the gross area and on the effective net area) that were introduced simultaneously with the new definition of effective net area modify the above conclusion. In addition, the traditional upper limit on the critical net area of 85% of the gross area (a requirement of the old code) is no longer a requirement of the new code. Both of these changes interact with the new effective net area requirement.

A valid assessment of the effect of these changes is best accomplished by a comparison of the allowable load each code permits in tension members. If one considers the allowable load on the effective net area, the value based on the new code is a function of three variables: the new reduction coefficient, the net area,* and the ultimate tensile strength of the steel. The allowable load based on the old code is a function of only two variables: the net area and the yield strength of the steel. First, form the load ratio of the allowable load defined by the new code criteria to the allowable load defined by the old code criteria. This ratio is the product of the ratio of the net areas, the new code net area reduction factor, and the ratio of the steel ultimate strength to the yield strength. Next, consider the ranges of all of the parameters mentioned above; these establish upper and lower limits for the ratio. For all steels allowed under the new code, this load ratio ranges from 1.5 to 0.69. For all steels allowed under the old code, this load ratio ranges from 1.6 to 0.88. It is apparent that, for those steels with load ratios less than 1.0, the new code is more conservative than the old. The margin of safety of some older designs therefore could be significantly lower when checked against the new code requirements.

2.6 SHEAR LOAD IN COPED BEAMS

The 1980 AISC Code [3] introduces additional control over the shear load permitted at beam end connections where the top flange has been coped.

---

*In making this comparison, one must be careful to note that the net area is not always the same under the old and new codes.

Web shear control in older codes did not distinguish between coped and uncoped beams or between shear allowed at connections and over the free span (except for requiring reinforcement of thin webs at connections). The shear load allowed was given by:

allowable shear load = 0.4 (yield strength) (gross web section).

The 1980 Code retains this limit, but introduces an additional requirement to protect against a failure mode associated with coped beams. For coped beams (and similar situations), a portion of the web may sever, failing along the perimeter of the connection holes. In particular, coped beam web connections where the fastener holes lie close to the butt end of the beam may be prone to such failures.

This web "tear out" failure is actually a combination of shear failure through the line of fasteners together with tensile failure across the shortest path to the beam end. The failure surface turns a corner with shear failure along a line trending upward through the holes, combined with tensile failure across a more-or-less horizontal line running out to the beam end.

The newly introduced shear limit is given as a function of the minimum net failure surface and the steel ultimate strength. Thus, the new requirements may or may not control a coped beam's allowable capacity in shear. Whether or not it does depends on both the connection geometry and the type of steel used.

When this requirement is controlling, coped beams designed by previous rules may be found, if checked against the new criteria, to have significantly smaller margins of safety than previously thought.

2.7 COLUMN WEB STIFFENERS AT FRAME JOINTS

The more recent editions of the AISC code mandate which columns must be stiffened at locations where beams of girders are rigidly attached to the column flange and also establish requirements for the geometry of such web stiffeners. These requirements are introduced to preclude local crippling at such frame joints.

No such guidance was provided by AISC-63 [2]. Older codes (such as AISC-63) left such matters to the designer's discretion. Consequently, there is no assurance that all such columns are adequately stiffened for current accident and faulted loadings.

2.8 LATERAL SUPPORT SPACING IN FRAMES (PLASTIC DESIGN METHOD)

The 1980 AISC Code contains changed spacing requirements for lateral supports in portions of members in frames where failure mechanisms are expected to form at ultimate load.

Members of such frames must not only be capable of developing a plastic hinge, but must also be stable enough to sustain moments larger than those computed on an elastic-perfect-plastic theory (because real steels work-harden at strains expected to occur at hinge locations). Previous lateral bracing requirements were developed for a limited range of steels. Research on high-strength steels has shown that, for certain ranges of slenderness ratio of the compression flange of such frame members, older specification bracing requirements were not sufficiently conservative.

The new specification requirements make the slenderness ratio limits a function of the steel yield strength and the member curvature (as expressed by the ratio of the lesser bending moment at the ends of the unbraced segment to the plastic moment).

The new specifications are more conservative for (1) any segment bent in double curvature regardless of its steel specification and (2) very high-strength steel members. The adequacy of frame members bent in single curvature and constructed of steels whose yield strength exceeds 36 ksi should be examined on a case-by-case basis.

The new requirements may reduce the margins of safety thought to exist in:

1. structures designed under the plastic requirements of older codes
2. elastically designed structures sized to carry a smaller maximum load than is now required by current accident and faulted load combinations. In this case, plastic logic may have to be invoked to justify the adequacy of exisiting structures. Nonconformance with

current bracing requirements may substantially restrict the capability of frame members to carry code-acceptable overloads.

2.9 BRACKETS AND CORBELS

ACI 349-76 [4], Section 11.13 contains design requirements for short brackets and corbels which are considered primary load-carrying members; no comparable requirements are provided in ACI 318-63 [5].

The requirements apply to brackets and corbels having a shear span-to-depth ratio of unity or less. They provide minimum and maximum limits on tension and shear reinforcement, limits on ultimate shear stress in concrete, and constraints on member geometry and location of reinforcement.

Brackets and corbels designed under earlier codes may or may not satisfy the newly imposed limits. If they do not, they may be prone to non-ductile failure (which occurs suddenly and without warning) and may exhibit smaller margins of safety than those currently required.

2.10 SPECIAL PROVISIONS FOR WALLS

2.10.1 Shear Walls

ACI 349-76, Sections 11.15.1 through 11.15.6 specify requirements for reinforcing and permissible shear stresses for in-plane shear loads on walls. The ACI 318-63 Code had no specific requirements for in-plane shear on shear walls.

2.10.2 Punching Shear

ACI 349-76, Section 11.15.7 specifies permissible punching shear stresses for walls. ACI 318-63 had no specific provisions for walls for these stresses. Punching loads are caused by relatively concentrated lateral loads on the walls. These loads may be from pipe supports, equipment supports, duct supports, conduit supports, or any other component producing a lateral load on a wall.

2.11 ELEMENTS LOADED IN SHEAR WITH NO DIAGONAL TENSION (SHEAR FRICTION)

The provisions for shear friction given in ACI 349-76 did not exist in ACI 318-63. These provisions specify reinforcing and stress requirements for situations where it is inappropriate to consider shear as a measure of diagonal tension.

2.12 ELEMENTS SUBJECT TO TEMPERATURE VARIATIONS

The ACI 349-76, Appendix A requirements for thermal considerations in nuclear safety-related, reinforced concrete structures do not have a comparable counterpart in ACI 318-63.

The new provisions give guidance in the form of general design requirements and limiting concrete temperatures. New design provisions requires that the effects of temperature gradients and the effects of the difference between mean temperature and base temperature during normal operation or accident conditions be considered. Also, thermal stresses are to be evaluated considering the stiffness and rigidity of members and the degree of restraint of the structure. Concrete temperature limits are specified, both for normal operation or other long-term periods and for accident or other short-term periods. In addition, special temperature limits are provided for localized conditions such as around penetrations and from steam or water jets that might strike concrete structures as a result of postulated pipe breaks.

All requirements of the older codes are a result of experience and research with reinforced concrete at temperatures primarily related to normal weather conditions. Consequently, the older codes did not reflect major effects of high-temperature exposures.

Research into the effects of temperature on mechanical properties of concrete reveals that generally both strength and stiffness degrade significantly with high temperature beginning at about 120° to 150°F. Both properties are reduced as a result of a combination of mechanisms. Above these temperatures, microcracking (which results from differential expansion of aggregate and the cement paste matrix) and paste dehydration are significant contributors to loss of strength and stiffness.

The new requirements may reduce the margins of safety previously thought to exist in older designs if the newly specified general design requirements were not given appropriate consideration or if current temperature limits are exceeded. In addition, the new code provides specific guidance for thermal stress analysis in cases where thermal gradients exist and defines (in the commentary to Appendix A) three acceptable approaches to the analysis. It is possible that the structural analysis of some plants designed to earlier codes may not have fully taken into account stresses from thermal loadings. Where this is true, the computed margins of safety may overstate the actual structural integrity.

2.13 COLUMNS WITH SPLICED REINFORCING

The ACI 349-76, Section 7.10.3 requirements for columns with spliced reinforcing did not exist in the ACI 318-63 Code. The ACI 349-76 Code requires that splices in each face of a column, where the design load stress in the longitudinal bars varies from fy in compression to 1/2 fy in tension, be developed to provide at least twice the calculated tension in that face of the column (splices in combination with unspliced bars can provide this if applicable). This code change requires that a minimum of 1/4 of the yield capacity of the bars in each face of the column be developed by both spliced and unspliced bars in that face of the column.

2.14 EMBEDMENTS

Appendix B of ACI 349-80 provides rules for the design of steel embedments in concrete; the design of embedments is not specifically addressed in ACI 318-63.

Current requirements of Appendix B are based upon ultimate strength design using factored loads. The anchorage design is controlled by the ultimate strength of the embedment steel. Ductile failure (i.e., steel yields before concrete fails) is postulated.

Under the provisions of ACI 318-63, the design of embedments was left to the discretion of the designer. Working stress design methods were widely used.

Consequently, it is likely that original embedment designs do not fully conform to current criteria. Review of such designs to determine the implications with respect to margins of safety is therefore judged a desirable precaution.

2.15 DUCTILE RESPONSE TO IMPULSE LOADS

Appendix C to ACI 349-76 [4] contains design rules for structures which may be subjected to impulse or impact loads; no such provisions occur in ACI 318-63 [5].

The rules of Appendix C are intended to foster ductile response (i.e., steel yields prior to concrete failure) of nuclear structures if and when they experience impulse or impact loads. For structures built to codes not containing such provisions, there is no assurance that sufficient design effort was directed toward proportioning members to provide energy absorbtion capability. Consequently, such structures might be prone to non-ductile, sudden failure should they ever experience postulated accident loadings such as jet impingement, pipe whip, compartment depressurization, or tornado missiles.

2.16 TANGENTIAL SHEAR (CONTAINMENTS)

Paragraph CC-3421.5, Tangential Shear, of Section III, Division 2 of the ASME Boiler and Pressure Vessel Code [6] addresses the capacity of reinforced concrete containments to carry horizontal shear load. It provides code-acceptable levels of horizontal shear stress that the designer may credit to the concrete. No specific guidance in this matter exists in ACI 318-63.

The provisions associate the allowable concrete stress in horizontal shear with the concrete properties, the manner in which lateral loads are imposed on the structure, and the presence of sufficient reinforcement to assure that the assumed shear capacity of concrete can be developed.

Sufficient diagonal reinforcement (or its demonstrated equivalent) is to be supplied to carry, without excessive strain, shear in excess of that permitted in the concrete. A major consideration here is the preservation of the structural integrity of the liner.

In containments constructed to older codes, such matters were left to the discretion of the designer, who may or may not have provided the horizontal shear capacity at controlled strains that the code currently requires.

2.17 AREAS OF CONTAINMENT SHELL SUBJECT TO PERIPHERAL SHEAR

Concrete containment design is currently governed by the ASME Boiler and Pressure Vessel Code, Section III, Division 2, 1980 [6]. The provisions for peripheral (punching) shear appear in code Section CC-3421.6. These provisions are similar to the ACI 318-63 Code [5] provisions for slabs and footings, except that the allowable punching shear stress in CC-3421.6 includes the effect of shell membrane stresses. For membrane tension, the allowable concrete punching shear stress in the ASME Code is less than that allowed by ACI 318-63.

2.18 AREAS OF CONTAINMENT SHELL SUBJECT TO TORSION

Concrete containment design is currently governed by the ASME Boiler and Pressure Vessel Code, Section III, Division 2, 1980. Section CC-3421.7 of the code contains provisions for the allowable torsional shear stress in the concrete. Such provisions were not contained in the ACI 318-63 Code. The present allowable torsional shear stress includes the effects of the membrane stresses in the containment shell and is based on a criterion that limits the principal membrane tension stress in the concrete.

2.19 THERMAL LOADS

ACI 349-76 Appendix A and ASME B&PV Code, Section III, Div. 2, CC-3440 contains requirements for consideration of temperature variations in concrete that are not contained in ACI 318-63.

The new provisions require consideration of the effects of thermal gradients and of the effects depending on the mean temperature distribution and the base temperature distribution during normal operation or accident conditions. The new provisions also require that thermal stresses be evaluated considering the stiffness and rigidity of members and the degree of restraint of the structure.

An assessment is to be made of the analytical methods used to determine thermal stresses as compared to current code-acceptable practices, e.g., those discussed in ACI 349.1R-80 and the commentary to ACI 349R-80.

If the methods used for design produce stress results which are significantly different from those current procedures generate, perceived margins of safety could be affected.

2.20 AREAS OF CONTAINMENT SHELL SUBJECT TO BIAXIAL TENSION

Increased tensile development lengths are required by Section CC-3532.1.2 of Reference 6 for reinforcing steel bars terminated in areas of reinforced concrete containment structures which may experience biaxial tension. For biaxial tension loading, bar development lengths (including both straight embedment lengths and equivalent straight length for standard hooks) are required to be increased by 25% over the standard development lengths required for uniaxial loading. Nominal temperature reinforcement is excluded from these special provisions. ACI 318-63 had no requirements related to this increase in development length.

2.21 BRACKETS AND CORBELS (ON THE CONTAINMENT SHELL)

The ACI 318-63 Code did not specify requirements for brackets and corbels. Provisions for these components are included in the ASME Boiler and Pressure Vessel Code, Section III, Division 2, Section CC-3421.8. These provisions apply to brackets and corbels having a shear-span-to-depth ratio of unity or less. The provisions specify minimum and maximum limits for tension and shear reinforcing, limits on shear stresses, and constraints on the member geometry and placement of reinforcing within the member.

3. REVIEW METHOD AND TABULAR PRESENTATIONS

The information relating to SEP Topic III-7.B which was supplied to the NRC by Consumers Power Company and relied upon for this review is contained in the following documents:

1. D. J. VanderWalle, Nuclear Licensing Administrator, Consumers Power Company
   Letter to D. M. Crutchfield, Chief, Operating Reactor Branch No. 5, USNRC
   Subject: Docket 50-255 - License DPR-20, Palisades Plant, SEP Topic III-7.B, "Design Codes, Design Criteria, and Load Combinations"
   October 8, 1982

2. K. A. Toner, Senior Licensing Engineer, Consumers Power Company
   Letter to D. M. Crutchfield, Chief, Operating Reactor Branch No. 5, USNRC
   Subject: Docket 50-255 - License DPR-20, Palisades Plant, SEP Topic III-7.B,* "Design Codes, Design Criteria, and Load Combinations" - Action Plan and Schedule to Address One Remaining Open Item
   January 12, 1983

3. K. A. Toner, Senior Licensing Engineer, Consumers Power Company
   Letter to D. M. Crutchfield, Chief, Operating Reactor Branch No. 5, USNRC
   Subject: Docket 50-255 - License DPR-20, Palisades Plant, SEP Topic III-7.B., "Design Codes, Design Criteria, and Load Combinations" - Action Plan and Schedule to Address One Remaining Open Item
   February 28, 1983

4. K. A. Toner, Senior Licensing Engineer, Consumers Power Company
   Letter to D. M. Crutchfield, Chief, Operating Reactor Branch No. 5, USNRC
   Subject: Docket 50-255, License DPR-20, Palisades Plant, SEP Topic III.7.B, "Design Codes, Design Criteria, and Load Combinations," Evaluation of Steel Embedment
   September 23, 1983

Before undertaking licensee report reviews, FRC prepared tabular forms to be used as a working tool during the review process and also to document the review work and its findings when the review was completed.

These tables are intended to:

1. establish a systematic and comprehensive review procedure
2. standardize, as much as possible, the review process for all licensees

3. present a relatively compact overview of each licensee's SEP Topic III-7.B compliance status.

Two such forms were prepared, one related to design code changes and the other to the differences between loads and load combinations used for design and loads and load combinations current today.*

The form sheets provide space to summarize key information reported in licensee responses. Certain items (such as descriptions of Scale A code changes, conclusions, and comments) frequently are not adaptable to abbreviated summary. For such items, the form sheets refer the reader either to sections of this TER where the matter is developed more fully or to an extended note list compiled on separate sheets. The note list, although detached from the main table in order to allow a fuller discussion, accompanies each table and should be regarded as an integral part of it.

The form sheet consists of four major columnar sections which:

1. identify each Scale A item
2. state the action that the licensee took or the logic that the licensee presented to resolve the item
3. provide an assessment of engineering conclusions that may be reasonably drawn from the evidence provided
4. summarize the licensee's compliance status with respect to the item.

Items listed on the tables are designed code changes (or itemized load combinations) designated Scale A. This list is drawn directly from TER-C5257-324, the earlier report on this topic [1].

Licensees may choose to address potential concerns stemming from Scale A items in two ways:

1. generically, i.e., on an overall basis which resolves the concern for all plant structures collectively, or
2. on a structure-by-structure basis.

*The tables for load and load combinations do not appear in this report; instead a format corresponding more closely to Consumers Power Company's presentation (in Reference 7) is used.

The form sheets are compiled in a manner matching the licensee's approach, with one form sheet containing generically treated matters and with structure-specific form sheets for each structure-specific matter.

Form sheets summarizing the review findings concerning the licensee's compliance status with respect to the implementation of SEP Topic III-7.B aspects related to design code changes follow in Section 4. A discussion of the review findings concerning the licensee's compliance status with respect to load and load combination changes is presented in Section 5.

4. TABULAR SUMMARY OF REVIEW FINDINGS OF LICENSEE COMPLIANCE STATUS CONCERNING IMPLEMENTATION OF SEP TOPIC III-7.B IMPACT OF DESIGN CODE CHANGES

Form sheets summarizing the review findings concerning technical aspects with respect to the implementation of SEP Topic III-7.B as related to design code changes follow.

SUMMARY OF LICENSEE COMPLIANCE STATUS --
IMPACT OF DESIGN CODE CHANGES

PLANT: Palisades
STRUCTURE: All steel structures

CODE CHANGE CITED AS SCALE A IN TER-5257-324			LICENSEE'S ACTION TO RESOLVE POTENTIAL CONCERN			EVALUATION OF LICENSEE'S ACTION			LICENSEE STATUS	
REFERENCED CODES AND PARAGRAPH		DESCRIPTION OF CODE CHANGE (See Indicated Report Section)	REFERENCE		APPROACH	IS METHOD VALID AND APPROPRIATE?	IS SUFFICIENT EVIDENCE REPORTED TO JUSTIFY CONCLUSIONS?	CONCLUSIONS AND COMMENTS (SEE NOTE)	STATUS WITH RESPECT TO THIS CODE CHANGE	FURTHER ACTION REQUIRED
CURRENT	DESIGN		DOCUMENT	PAGE NUMBER						
AISC 1980	AISC 1963									
1.11.4	1.11.4	Shear connectors in composite beams (2.1)	Ref. 7	p. 6 Sect. C.1.a	Licensee affirms there is no significant composite design	Yes	Yes	Code change not applicable to Palisades (C-1)	Resolved	None
1.11.5	--	Composite beams or girders with formed steel deck (2.2)	Ref. 7	p. 6 Sect. C.1.b	Licensee states that design of steel beams when used with steel decks is primarily controlled by construction loads	Possibly	No. More definitive discussion required	C-2	RAI sent to Licensee	Respond to RAI
1.10.6	1.10.6	Hybrid girders (2.3)	Ref. 7	p. 6 Sect. C.1.c	Licensee affirms no hybrid girders exist in plant structures	Yes	Yes	This code change not applicable to Palisades	Resolved	None
1.9.1.2 and App. C	1.9.1	Compression elements having width/thickness ratio greater than specified in 1980 Code (2.4)	Ref. 7	p. 7 Sect. C.2	Not clear. Licensee statements regarding this item do not appear to directly address the issue	No	No. More relevant discussion needed	C-4	RAI sent to Licensee	Respond to RAI
1.14.2.2	--	Tension members, when load is transmitted by bolts or rivets (2.5)	Ref. 7	p. 2 of Cover Letter	Licensee made generic comparison of Code provisions for the case of A-36 steel (used at Palisades)	Yes	Yes	For A-36 steel, old code is more conservative	Resolved	None

SUMMARY OF LICENSEE COMPLIANCE STATUS --
IMPACT OF DESIGN CODE CHANGES

PLANT: Palisades
STRUCTURE: All steel structures
Sheet 2 of 6

CODE CHANGE CITED AS SCALE A IN TER-5257-324			LICENSEE'S ACTION TO RESOLVE POTENTIAL CONCERN			EVALUATION OF LICENSEE'S ACTION			LICENSEE STATUS	
REFERENCED CODES AND PARAGRAPH		DESCRIPTION OF CODE CHANGE (See Indicated Report Section)	REFERENCE		APPROACH	IS METHOD VALID AND APPROPRIATE?	IS SUFFICIENT EVIDENCE REPORTED TO JUSTIFY CONCLUSIONS?	CONCLUSIONS AND COMMENTS (SEE NOTE)	STATUS WITH RESPECT TO THIS CODE CHANGE	FURTHER ACTION REQUIRED
CURRENT	DESIGN		DOCUMENT	PAGE NUMBER						
AISC 1980	AISC 1963									
1.5.1.2.2	--	Beam end connection with top flange coped, if subject to shear (2.6)	Ref. 7	p. 7 Sect. C.4.a	Licensee speculates that: 1. Construction loads may control design. 2. Bolting may control design 3. Webs may have adequate shear area	Yes. Any of these considerations are valid, if true	No. More definite evidence required	C-6	RAI sent Licensee	Respond to RAI
1.15.5.2 through 1.15.5.4	--	Column web stiffeners for connections carrying moment or restrained member connection (2.7)	Ref. 7	p. 7 Sect. C.4.b	Licensee affirms that restrained member connections are used nowhere (except for pipe-whip restraints)	Yes	Yes	C-7	Resolved	None
2.9	2.8	Spacing of lateral supports of members designed using plastic design methods (2.8)	Ref. 7	p. 8 Sect. 5	Licensee affirms that all steel structural members were designed to function elastically	Yes	Yes	C-8	Resolved for all loadings where reactions remain elastic at beam supports	No action required unless plastic logic is subsequently used to justify the integrity of the existing structures under Scale A loading combinations. If so, Licensee's stated conclusion must be reexamined.

SUMMARY OF LICENSEE COMPLIANCE STATUS --
IMPACT OF DESIGN CODE CHANGES

CODE CHANGE CITED AS SCALE A IN TER-5257-324			LICENSEE'S ACTION TO RESOLVE POTENTIAL CONCERN			EVALUATION OF LICENSEE'S ACTION			LICENSEE STATUS	
REFERENCED CODES AND PARAGRAPH: CURRENT	DESIGN	DESCRIPTION OF CODE CHANGE (See Indicated Report Section)	REFERENCE: DOCUMENT	PAGE NUMBER	APPROACH	IS METHOD VALID AND APPROPRIATE?	IS SUFFICIENT EVIDENCE REPORTED TO JUSTIFY CONCLUSIONS?	CONCLUSIONS AND COMMENTS (SEE NOTE)	STATUS WITH RESPECT TO THIS CODE CHANGE	FURTHER ACTION REQUIRED
ACI 349-76	ACI 318-63									
11.13	--	Short brackets and corbels (not on the containment shell) (2.9)	Ref. 7	p. 8 Sect. C-6	Licensee points out that the allowable original design is more conservative than present allowable	Possibly	No. Response neglects newly introduced controls on reinforcement	C-9	RAI sent to Licensee	Respond to RAI
11.16.1 through 11.16.6	--	Shear walls used as primary load-carrying members (2.10.1)	Ref. 7	p. 8 Sect. C-7	Resolved under separate SEP Topic	--	--	--	Resolved	None
11.16.7	--	Punching shear stress for walls (2.10.2)	--	--	Not directly addressed	--	--	--	RAI sent to Licensee	Respond to RAI
11.15	--	Structural elements loaded in shear where it is inappropriate to consider shear as a measure of diagonal tension (shear friction) (2.11)	Refs. 7 and 8	p. 8 Sect. C-8 (of Ref. 7) Cover Letter (of Ref. 8)	Licensee response implies there are no significant applications at Palisades	Possibly	Possibly. It is not clear from response whether or not all applications were considered	C-11	Clarification via RAI	Respond to RAI

TER-C5506-422

SUMMARY OF LICENSEE COMPLIANCE STATUS --
IMPACT OF DESIGN CODE CHANGES

CODE CHANGE CITED AS SCALE A IN TER-5257-324			LICENSEE'S ACTION TO RESOLVE POTENTIAL CONCERN			EVALUATION OF LICENSEE'S ACTION			LICENSEE STATUS	
REFERENCED CODES AND PARAGRAPH: CURRENT	DESIGN	DESCRIPTION OF CODE CHANGE (See Indicated Report Section)	REFERENCE: DOCUMENT	PAGE NUMBER	APPROACH	IS METHOD VALID AND APPROPRIATE?	IS SUFFICIENT EVIDENCE REPORTED TO JUSTIFY CONCLUSIONS?	CONCLUSIONS AND COMMENTS (SEE NOTE)	STATUS WITH RESPECT TO THIS CODE CHANGE	FURTHER ACTION REQUIRED
ACI 349-76	ACI 318-63									
Appendix A	--	Concrete regions subject to high-temperature time-dependent and position-dependent temperature variations (2.12)	Ref. 7	p. 8 Sect. C-9	Licensee states no significant sources of thermal load exist	Possibly	No. Quantitative information needed to support Licensee statement	C-12	RAI sent to Licensee	Respond to RAI
7.10.3	805	Column with spliced reinforcement subject to stress reversal (2.13)	Ref. 7	p. 8 Sect. C-10	Licensee affirms no column members in buildings experience stress reversals	Yes	Yes	C13	Resolved	None
Appendix B	--	Steel embedment used to transmit load to concrete (2.14)	Refs. 9 and 10	--	Licensee supplied plan for review procedure (Ref. 9) and an evaluation (Ref. 10)	--	--	Reference 10	is under current review	
Appendix C	--	Elements subject to implusive and impactive loads, whose failure must be precluded (2.15)	--	--	Response to this concern is relegated to discussion under loads and load combinations	--	--	--	To be determined per findings of SEP Topic III-5.B	--

SUMMARY OF LICENSEE COMPLIANCE STATUS --
IMPACT OF DESIGN CODE CHANGES

PLANT: Palisades
STRUCTURE: Containment

CODE CHANGE CITED AS SCALE A IN TER-5257-324			LICENSEE'S ACTION TO RESOLVE POTENTIAL CONCERN			EVALUATION OF LICENSEE'S ACTION			LICENSEE STATUS	
REFERENCED CODES AND PARAGRAPH		DESCRIPTION OF CODE CHANGE (See Indicated Report Section)	REFERENCE		APPROACH	IS METHOD VALID AND APPROPRIATE?	IS SUFFICIENT EVIDENCE REPORTED TO JUSTIFY CONCLUSIONS?	CONCLUSIONS AND COMMENTS (SEE NOTE)	STATUS WITH RESPECT TO THIS CODE CHANGE	FURTHER ACTION REQUIRED
CURRENT	DESIGN		DOCUMENT	PAGE NUMBER						
ASME B&PV Code Section III Div 2, 1980	ACI 318-63									
CC-3421.5	--	Containment transmitting in-plane shear (2.16)	Ref. 7	p. 8 Sect. C-11	Licensee points out this item found insignificant per NUREG/CR-158C	--	--	--	Resolved	None
CC-3421.6	1707	Region of the containment shell subject to peripheral shear (2.17)	Ref. 7	p. 9 Sect. C-12	Not clear. Licensee does not clearly state how punching shear was evaluated	--	--	C-17	RAI sent to Licensee	Respond to RAI
CC-3421.7	921	Region of containment shell subject to torsion (2.18)	Ref. 7	p. 9 Sect. C-13	Licensee states that no shell regions (except at penetrations) are subject to torsion. Additional reinforcement is placed at these locations	Yes	Yes	C-18	Resolved	None
CC-3440 (b), (c)	--	Elements subject to transient thermal loading (2.19)	Ref. 7	p. 8 Sect. C-9	Licensee states no significant sources for significant thermal loads exist	Possibly	No. Quantitative information needed to qualify comment	--	RAI sent to Licensee	Respond to RAI

SUMMARY OF LICENSEE COMPLIANCE STATUS --
IMPACT OF DESIGN CODE CHANGES

CODE CHANGE CITED AS SCALE A IN TER-5257-322			LICENSEE'S ACTION TO RESOLVE POTENTIAL CONCERN			EVALUATION OF LICENSEE'S ACTION			LICENSEE STATUS	
REFERENCED CODES AND PARAGRAPH		DESCRIPTION OF CODE CHANGE (See Indicated Report Section)	REFERENCE		APPROACH	IS METHOD VALID AND APPROPRIATE?	IS SUFFICIENT EVIDENCE REPORTED TO JUSTIFY CONCLUSIONS?	CONCLUSIONS AND COMMENTS (SEE NOTE)	STATUS WITH RESPECT TO THIS CODE CHANGE	FURTHER ACTION REQUIRED
CURRENT	DESIGN		DOCUMENT	PAGE NUMBER						
ASME B&PV Code Section III Div 2, 1980	ACI 318-63									
CC-3532.1.2	--	Areas of containment shell subject to biaxial tension (2.20)	Ref. 7	p. 9 Item C-14	Licensee points out that containment is prestressed	Yes	Yes	Code change not applicable to Palisades containment	Resolved	None
CC-3421.8	--	Brackets and corbels in containment shell (2.21)	Ref. 7	p. 10 Item C-15	Licensee consolidates discussion with that of corbels in structures external to containment. Justification of acceptability under current criteria relies on more stringent shear stress limit than currently required	Perhaps	No. Justification does not consider current requirements upon reinforcement	C-21	RAI sent to Licensee	Respond to RAI

NOTES:

In the following notes, the Licensee's conclusion is presented first, followed by the reviewer's comments, if any, in brackets.

C-1. There were no composite structures in the Palisades Plant designed to the 1963 AISC code. Partial composite design was employed for the baler room roof to account for uplift pressure generated by the tornado, in accordance with the 1971 code. Currently, a new addition is being built above the baler room, which will become an interior structure.

[Acceptable]

C-2. The main purposes for the combined use of steel beams and steel deck at the Palisades Plant were to facilitate construction and to eliminate the need for additional formworks. Structural steel beams were primarily designed to support the construction loads, except those addressed in the preceding Section C.1.

[Additional information requested]

C-4. In the 1963 edition of the AISC specification appendix, Section 1.9 gives the limiting width-thickness ratios (b/t) for different structural shapes. Those limiting ratios, which are the lower bound ratios stipulated in Appendix C of AISC 1980 edition, are easy to follow and require no reduction in stress. Provisions were made in the 1963 code to allow for higher b/t, provided that special design consideration was imposed. However, it has not been the common industrial design practice to compensate for possible small material savings by using a more sophisticated design procedure. Furthermore, structural shapes addressed under Subsection 1.9.1.2 of the AISC code had not been used as the primary load supporting members in the Palisades Plant. Therefore, the safety margin of the Plant structures has not been affected.

[Additional information requested]

C-6. Review of design documents indicates that both welded and bolted connections were used. Furthermore, structural steel beams were primarily designed to carry construction loads rather than being designed as major load carrying members. It was also found that the 1963 code gives more conservative connection strength using ASTM 307 bolts. However, with ASTM 325 bolts, as used at the Palisades Plant, only a few lighter weight wide flange beams for each size may not be conservative. In common design practice for beam selection, the limitation on lateral unsupported length tends to direct the designer to avoid lateral weakness by choosing a slightly heavier beam, which would normally possess more than adequate web thickness for the compatible connection. Therefore, the safety margin of the Plant structures has not been affected.

[Additional information requested]

C-7. The restrained member connections were used only for pipe whip restraints in the Palisades Plant. The review of pipe supports/restraints is outside the scope of this SEP topic.

[Acceptable]

C-8. All structural steel members were designed to function elastically in the Plant. The provision of AISC Manual, Subsection 2.9, does not apply.

[Acceptable]

C-9. <u>Short Brackets and Corbels</u>

The allowable shear stress, $2\phi\sqrt{f'_c} = 1.7\sqrt{f'_c}$, was used in the original design, which is more conservative than the limiting allowable shear stresses, $3.72\sqrt{f'_c}$, obtained from equation 11.23 of ACI 349-76, Section 11.13.2, for $f'_c/f_y = 0.075$, $a/d = 1$ and $Nu/Vu = 0.2$ (Nu is usually negligible). Therefore the provision stated in Section 11.13.2 is automatically net.

[Additional information requested]

C-11. At the Palisades Plant, there are limited structural elements that are subjected to direct shear. A sample evaluation of such a bracket to ACI 39-80, Section 11.7, shows that there is adequate reinforcement.

[Additional information requested]

C-12. The only high-temperature sources are high-temperature piping and possible pipe breaks. There is no high-temperature piping embedded inside the concrete structure. Exposed high-energy lines are properly insulated. During a pipe break event, localized high temperature dissipates within seconds. Other temperature variations within the Plant do not warrant concern over structural integrity. Therefore, this item does not apply.

[Additional information requested]

C-13. No columns are subject to stress reversal at the Palisades Plant. The provision stated in Section 7.10.3 of ACI 349-76 does not apply.

[Acceptable]

C-17. The only shell structure at the Palisades Plant is prestressed concrete containment. The applicable section of ACI 318-63 for shear is Section 2610 of Chapter 26, not Section 1707 of Chapter 17, which was cited in Appendis B of the Palisades FSAR.

Due to the presence of prestressing force, the entire concrete containment shell is under compression, except at the junction of the shell and the basemat under certain loading combinations (FSAR Table 5-1). The provision stated in ACI 318-63, concerning ultimate shear is $3.5\sqrt{f'_c}$. This value is less than the lower bound figure stipulated in CC-3421.6, ASME Code, Section III, Division 2 ($4\sqrt{f'_c}$), because f_m and f_h are in compression at all times. This criterion is applicable only to nonprestressed concrete structures.

[Additional information requested]

C-18. No torsional moments exist in the region of the containment shell, except at major penetrations. However, torsion at major penetrations is also insiginficant in comparison with other primary loads. Furthermore, additional shear reinforcements have been placed around the penetrations. Therefore, the consideration of torsion will not adversely impact the integrity of the containment structure.

[Acceptable]

C-21. [Refer to C-9]

5. REVIEW FINDINGS - LOADS AND LOAD COMBINATIONS

An important aspect of current criteria is the loading combinations for which Seismic Category I structures must be designed. One objective of TER-C5257-324 [Reference 1] was to assemble technical information to assist the NRC in making safety evaluations concerning the structural integrity of Palisades Seismic Category I plant structures, based on a comparison of loading combinations actually used for design with the loading combinations currently required.

Section 10.4 of TER-C5257-324 provides tables, one for each Seismic Category I structure, which are intended to give an overview of this comparison as it relates to Palisades. The tables shows:

1. The generalized loading combinations currently specified (in NRC's Standard Review Plan) as appropriate for the structure.

2. The appropriate structure-specific loading combinations. These are obtained from the generalized loading combinations by striking off loads believed to be inapplicable or negligible.

3. The loading combinations actually used for design. These were obtained from the FSAR or other relevant documentation made available to the reviewers. Loads actually combined are indicated by encircling (in the appropriate load combinations) each load used in the summation considered for design.

Licensees were requested to review these tables to ensure their accuracy.

Disparities between the load combinations actually used for design and those currently specified are readily apparent on these tables. If the load combinations used were in complete accord with present criteria, each load symbol in the table would appear as either struck or encircled. Load combinations not considered and loads omitted from the loading combinations stand out as unencircled items.

When discrepancies were found to exist, a limited number of loading combinations (usually two) were designated Scale A_x. Licensees were asked to review Scale A_x loading combinations and provide documented evidence of structural adequacy under these loading combinations as currently specified.

The following sections present, on a structure-by-structure basis, the review findings concerning the Licensee's compliance status with respect to the load and load combination aspects of SEP Topic III-7.B.

5.1 CONTAINMENT STRUCTURE

5.1.1 Load Combinations

Based on the information provided by Consumers Power Company [7] and information developed in Topic III-5.A, the following sets of loads appear to be proper building-specific loading combinations for concrete containment under current criteria.

1. D + L + F + To + Ro
2. D + L + F + To + Eo + Ro
3. D + L + F + To + W + Ro
4. D + 1.3L + F + To + 1.5Eo + Ro
5. D + 1.3L + F + To + 1.5W + Ro
6. D + L + F + To + Ess + Ro
7. D + L + F + To + Wt + Ro
8. D + L + F + 1.5Pa + Ta + Ra
9. D + L + F + Pa + Ta + 1.25Ra
10. D + L + F + 1.25Pa + Ta + 1.25Eo + Ra
11. D + L + F + 1.25Pa + Ta + 1.25W + Ra
12. D + L + F + Ha + To + E
13. D + L + F + Ha + To + W
14. D + L + F + Pa + Ta + Ess + Ra + Rrr + Rrj

Load Combinations 8 and 14 are cited in TER-C5257-324 as Scale A_x.

5.1.2 Licensee's Evaluation

Load Combination 8 (R_a)

The specific design details for loading component R_a cannot be located in the original design calculation. However, R_a is only a localized point loading. Consideration of R_a will not infringe upon the structural integrity of the containment structure because sufficient margin exists from considering the other critical uniform load ($1.5P_a$). Furthermore, the containment was designed with adequate heat sink in addition to the spray system to control the thermal load during accident conditions. Load R_a is not expected to be significant.

Load Combination 14 [$R_a + R_r$ (Y_r, Y_j, Y_m)]

Inside the containment structure, pipe restraints have been provided at all major pipe break locations to mitigate the pipe break effects. The impact from $R_a + R_r$ is deemed insignificant. In addition, Load Combination 14 is less critical than Load Combination 10.

5.1.2 Review Comments

The Licensee's comments concerning Load Combination 8 may well be valid, but no assessment can be made without more specific information. This information should describe the Licensee's investigative approach and its findings in a quantitative fashion. Pending this, the Scale A_x rating should be retained.

It is understood that SEP Topic III-5.A found that pipe breaks inside containment can affect the containment liner and containment penetrations, and that Consumers Power Company has made structural analyses investigating these effects and has submitted them to the NRC. These analyses were not made available for the present review. The status of Load Combination 13 should be made in conformance with such a review.

5.2 LINER

5.2.1 Load Combinations

Based on the information provided by Consumers Power Company [7] and information developed in Topic III-5.A, the following sets of loads appear to be proper structure-specific loading combinations for the containment liner.

1. D + L + F + To + Ro
2. D + L + F + To + Eo + Ro
3. D + L + F + To + W + Ro
4. D + L + F + To + Eo + Ro
5. D + L + F + To + W + Ro
6. D + L + F + To + Ess + Ro
7. D + L + F + To + Wt + Ro
8. D + L + F + Pa + Ta + Ra
9. D + L + F + Pa + Ta + Ra
10. D + L + F + Pa + Ta + Eo + Ra
11. D + L + F + Pa + Ta + W + Ra
12. D + L + F + Ha + To + Eo

13. D + L + F + Ha + To + W
14. D + L + F + Pa + Ta + Ess + Ra + Rrr + Rrj

Load Combinations 8 and 14 are cited in TER-C5257-324 as Scale A_x.

5.1.2 Licensee's Evaluation

Other than achieving strain compatibility with concrete containment, there is no load transferred to the containment liner. Therefore, the structural integrity of the liner plate is ensured if the structural integrity of the concrete containment is maintained.

5.2.3 Review Comments

The comments for the containment structure also apply to the liner.

5.3 CONTROL ROOM, DIESEL GENERATOR, AND SWITCHGEAR ROOMS

5.3.1 Load Combinations

Based on the information provided by Consumers Power Company [7], the following sets of loads appear to be proper building-specific loading combinations for concrete portions of this structure under current criteria.

1. 1.4D + 1.7L
2. 1.4D + 1.7L + 1.9E
3. 1.4D + 1.7L + 1.7W
4. (0.75) (1.4D + 1.7L + 1.7To + 1.7Ro)
5. (0.75) (1.4D + 1.7L + 1.9E + 1.7To + 1.7Ro)
6. (0.75) (1.4D + 1.7L + 1.7W + 1.7To + 1.7Ro)
7. 1.2D + 1.9E
8. 1.2D + 1.7W
9. D + L + To + Ro + E'
10. D + L + To + Ro + Wt
11. D + L + Ra
12. D + L + Ra + 1.25E'
13. D + L + Ra + 1.0E'

[Note: R_a has been retained in Combinations 11, 12, and 13 since the FSAR indicates that R_o was included in Combinations 5, 6, and 9.]

Load Combinations 10 and 13 are cited in TER-C5257-324 as Scale A_x.

5.3.2 Licensee's Evaluation

Load Combination 10 is less critical than Load Combination 9.

There are no postulated pipe breaks in these areas. Therefore, Load Combination 13 does not apply.

5.3.3 Review Comments

The status for Load Combination 10 should be determined in conformance with the findings of SEP Topic III-2 and III-4.A.

The Scale A_x rating may be removed from Load Combination 13.

5.4 SPENT FUEL POOL

5.4.1 Load Combinations

Based on the information provided by Consumers Power Company [7], the following sets of loads appear to be proper building-specific loading combinations for concrete portions of this structure under current criteria.

1. 1.4D + 1.7L
2. 1.4D + 1.7L + 1.9E
3. 1.4D + 1.7L + 1.7W
4. (0.75) (1.4D + 1.7L + 1.7To + 1.7Ro)
5. (0.75) (1.4D + 1.7L + 1.9E + 1.7To + 1.7Ro)
6. (0.75) (1.4D + 1.7L + 1.7W + 1.7To + 1.7Ro)
7. 1.2D + 1.9E
8. 1.2D + 1.7W
9. D + L + To + Ro + E'
10. D + L + To + Ro + Wt
11. D + L + Ta + Ra
12. D + L + Ta + Ra + 1.25E'
13. D + L + Ta + Ra + 1.0E'

Load Combinations 10 and 13 are cited in TER-C5257-324 as Scale A_x.

5.4.2 Licensee's Evaluation

Load Combination 10

The tornado missile load is not the controlling load case for the concrete portion of the spent fuel pool. This load was reviewed under SEP Topic III-4.

Load Combination 13

Impulse loads are not applicable to the spent fuel pool.

5.4.3 Review Comments

The status for Load Combination 10 should be determined in conformance with the findings of SEP Topic III-4.

The Scale A_x ratings may be removed from Load Combination 13.

5.5 AUXILIARY BUILDING ROOF OVER SPENT FUEL POOL

5.5.1 Load Combinations

Based on the information provided by Consumers Power Company [7], the following sets of loads appear to be proper building-specific loading combinations for concrete portions of this structure under current criteria.

1. 1.7D + 1.7L
2. 1.7D + 1.7L + 1.7E
3. 1.7D + 1.7L + 1.7W
4. 1.3 (D + L)
5. 1.3 (D + L + E)
6. 1.3 (D + L + W)
7. D + L + E'
8. D + L + Wt
9. D + L
10. D + L + 1.25E
11. D + L + E'

Load Combination 8 is cited in TER-C5257-324 as Scale A_x.

5.5.2 Licensee's Evaluation

The spent fuel pool enclosure was not designed for tornado loads. This structure was reviewed under SEP Topics III-2 and III-4.A.

5.5.3 Review Comments

The Scale A_x rating for Load Combination 8 is retained based solely on a clear nonconformance with current structural requirements. It is to be noted, however, that consequence analyses may prove that this is not a safety concern.

5.6 AUXILIARY BUILDING NEW FUEL AREA, PUMP ROOMS, AND RADWASTE TREATMENT AREA

5.6.1 Load Combinations

Based on the information provided by Consumers Power Company [7], the following sets of loads appear to be proper building-specific loading combinations for concrete portions of this structure under current criteria.

1. 1.4D + 1.7L
2. 1.4D + 1.7L + 1.9E
3. 1.4D + 1.7L + 1.7W
4. (0.75) (1.4D + 1.7L + 1.7To + 1.7Ro)
5. (0.75) (1.4D + 1.7L + 1.9E + 1.7To + 1.7Ro)
6. (0.75) (1.4D + 1.7L + 1.7W + 1.7To + 1.7Ro)
7. 1.2D + 1.9E
8. 1.2D + 1.7W
9. D + L + To + Ro + E'
10. D + L + To + Ro + Wt
11. D + L + Ta + Ra + 1.5Pa
12. D + L + Ta + Ra + 1.25Pa + 1.0 (Yr + Yj + Ym) + 1.25E'
13. D + L + Ta + Ra + 1.0Pa + 1.0 (Yr + Yj + Ym) + 1.0E'

Load Combinations 10 and 13 are cited in TER-C5257-324 as Scale A_x.

5.6.2 Licensee's Evaluation

Load Combination 10

The tornado missile loads do not apply to these areas because they are enclosed by other reinforced concrete structures.

Load Combination 13

There are no pipe breaks postulated in the pump room area. However, in the main steam and main feedwater penetration rooms, pipe restraints have been provided for high-energy lines to mitigate the consequences of pipe breaks. Safety margins of the Plant structures will not be affected by the code changes.

5.6.3 Review Comments

The Scale A_x rating for Load Combination 10 may be removed.

The status for Load Combination 13 should be determined in conformance with the findings of SEP Topic III-5.B.

5.7 INTAKE STRUCTURE

5.7.1 Load Combinations

Based on the information provided by Consumers Power Company [7], the following sets of loads appear to be proper building-specific loading combinations for concrete portions of this structure under current criteria.

1. 1.4D + 1.7L
2. 1.4D + 1.7L + 1.9E
3. 1.4D + 1.7L + 1.7W
4. (0.75) (1.4D + 1.7L)
5. (0.75) (1.4D + 1.7L + 1.9E)
6. (0.75) (1.4D + 1.7L + 1.7W)
7. 1.2D + 1.9E
8. 1.2D + 1.7W
9. D + L + E'
10. D + L + Wt
11. D + L
12. D + L + 1.25E'
13. D + L + 1.0E'

Load Combination 10 is cited in TER-C5257-324 as Scale A_x.

5.7.2 Licensee's Evaluation

The final safety evaluation for severe weather loads contained in SEP Topic II-2.A shows that Palisades design loads used in the original design are adequate. SEP Topic III-3.B concerns only the flooding condition and has no bearing on parapet roof loading. In addition, snow loading is not the controlling load case for roof design.

Structural integrity under earthquake was tacitly approved under SEP Topic III-6.

5.7.3 Review Comments

Additional information relating to design adequacy of plant strucuture roofs under severe weather loads has been requested.

Load Combination 10 relates to structural adequacy under tornado loads, not earthquake; therefore, the Licensee's response does not seem appropriate and the Scale A_x rating is retained pending clarification.

5.8 TURBINE BUILDING AUXILIARY FEEDWATER PUMP ENCLOSURE

5.8.1 Load Combinations

Based on the information provided by Consumers Power Company [7], the following set of loads appear to be a proper building-specific loading combinations for concrete portions of this structure under current criteria.

1. 1.4D + 1.7L
2. 1.4D + 1.7L + 1.9E
3. 1.4D + 1.7L + 1.7W
4. (0.75) (1.4D + 1.7L + 1.7Ro)
5. (0.75) (1.4D + 1.7L + 1.9E + 1.7Ro)
6. (0.75) (1.4D + 1.7L + 1.7W + 1.7Ro)
7. 1.2D + 1.9E
8. 1.2D + 1.7W
9. D + L + Ro + E'
10. D + L + Ro + Wt
11. D + L + Ra
12. D + L + Ra + 1.25 P'
13. D + L + Ra + 1.0 E'

Load combinations 10 and 13 are cited in TER-C5257-324 as Scale A_x.

5.8.2 Licensee's Evaluation

Load Combination 10

Tornado load was considered in the original design.

Load Combination 13

No pipe break was postulated inside the auxiliary feedwater pump room. The load combination is less severe than other load combinations.

5.8.3 Review Comments

The Scale A_x rating may be removed from Load Combination 10. The status for Load Combination 13 should be determined in conformance with the findings of SEP Topic III-5.B.

6. SUMMARY OF REVIEW FINDINGS

Number of Scale A and Scale A_x Rankings for Unresolved Items for Palisades Seismic Category I Structures

Issues	Scale A Code Changes: AISC 1963 vs. AISC 1980	Scale A Code Changes: ACI 318-63 vs. ACI 349-76	Scale A Code Changes: ACI 318-63 vs. ASME B&PV Sect. III Div. 2 1980
Raised by TER-C5257-324	8	8[a]	6
Resolved	5	2	4
To be resolved in accordance with findings of SEP Topic III-5.B	0	1	0
Remaining	3	5[b]	3

Issues	Scale A_x Load Combinations
Raised by TER-C5257-324	14
Resolved	4
To be resolved in accordance with findings of other SEP topics	6
Remaining	4[c]

a. Appears in TER-C5257-324 as seven items. The current report treats code shear provisions (Section 11.16) as two separate items.

b. Consumers Power Company's embedment evaluation is under current review.

c. A consequence analysis of missile penetration of fuel pool roof may reduce this to three items.

7. CONCLUSIONS AND RECOMMENDATIONS

The review of Consumers Power Company's evaluation of potential concerns raised by SEP Topic III-7.B with respect to the Palisades Plant discloses a number of items which cannot at this time be considered resolved. The largest number of these center on the evaluation of the impact on structural margins of safety due to changes in design code provisions and may be clarified when requested additional information is received from Consumers Power Company.

Relatively few issues remain which center on differences between loading combinations as currently specified compared to those actually used for analysis. Of all the SEP plants, the loading combination criteria used for the Palisades Plant most nearly conform to current requirements.

8. REFERENCES

1. Franklin Research Center, Technical Evaluation Report
Design Codes, Design Criteria, and Loading Combinations (SEP Topic III.7.B) Consumers Power Company, Palisades Nuclear Power Plant Unit 1,
TER-C5257-324
July 30, 1982

2. "Specification for Design, Fabrication, and Erection of Structural Steel for Buildings," Sixth Edition
American Institute of Steel Construction, Inc.
New York, NY
1963

3. "Specification for Design, Fabrication, and Erection of Structural Steel for Buildings," Eighth Edition
American Institute of Steel Construction, Inc.
New York, NY
1980

4. "Code Requirements for Nuclear Safety Related Concrete Structures" (ACI 349-76)
American Concrete Institute, Detroit, MI

5. "Building Code Requirements for Reinforced Concrete" (ACI 318-63)
American Concrete Institute, Detroit, MI

6. ASME Boiler and Pressure Vessel Code, Section III, Division 2
"Code for Concrete Reactor Vessels and Containments"
New York, NY
1980

7. D. J. VanderWalle, Nuclear Licensing Administrator, Consumers Power Company
Letter to D. M. Crutchfield, Chief, Operating Reactor Branch No. 5, USNRC
Subject: Docket 50-255, License DPR-20, Palisades Plant, SEP Topic III.7.B, "Design Codes, Design Criteria, and Load Combinations"
October 8, 1983

8. K. A. Toner, Senior Licensing Engineering, Consumers Power Company
Letter to D. M. Crutchfield, Chief, Operating Reactor Branch No. 5, UNSRC
Subject: Docket 50-255, License DPR-20, Palisades Plant, SEP Topic III.7.B, "Design Codes, Design Criteria, and Load Combinations," Action Plan and Schedule to Address One Remaining Open Item
January 12, 1983

9. K. A. Toner, Senior Licensing Engineering, Consumers Power Company
Letter to D. M. Crutchfield, Chief, Operating Reactor Branch No. 5, UNSRC
Subject: Docket 50-255, License DPR-20, Palisades Plant, SEP Topic III.7.B, "Design Codes, Design Criteria, and Load Combinations," Action Plan and Schedule to Address One Remaining Open Item
February 28, 1983

10. K. A. Toner, Senior Licensing Engineering, Consumers Power Company
Letter to D. M. Crutchfield, Chief, Operating Reactor Branch No. 5, USNRC
Subject: Docket 50-255, License DPR-20, Palisades Plant, SEP Topic III.7.B, "Design Codes, Design Criteria, and Load Combinations," Evaluation of Steel Embedment
September 23, 1983