ATTACHMENT D

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1) Table 3.7-1 Damping Factors for Strong Vibrations Within Elastic Limit
2) Page 3.8-24
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Table 3.7-1

DAMPING FACTORS FOR STRONG VIBRATIONS WITHIN THE ELASTIC LIMIT[a]

Item	Percentage of Critical Damping
Reinforced Concrete Structures	5.0
Steel Frame Structures	2.0
Welded Assemblies	1.0
Bolted and Riveted Assemblies	2.0
Vital Piping Systems	0.5

a This table is not applicable to Unit 3 LPCI corner room structural steel. For SSE, use damping values of Table 1 of Regulatory Guide 1.61

3.8.4.1.3 Loads and Load Combinations

General requirements for the design of all structures and equipment include provisions for resisting the dead loads, live loads, and wind or seismic loads with impact loads considered part of the live load. Selection of materials to resist these loads is based on standard practice in the power plant field. Their use is governed by the building codes valid at the site of construction and the experience and knowledge of the designers and builders.

The loads of concern include the following:

D = dead load of structure and equipment plus any other permanent loads contributing stress, such as soil or hydrostatic loads or operating pressures, and live loads expected to be present when the plant is operating

P = pressure due to LOCA

R = jet force or pressure on structure due to rupture of any one pipe

H = force on structure due to thermal expansion of pipes under operating conditions

T = thermal loads on containment due to LOCA

E = OBE load (0.10 g horizontal ground acceleration, 0.067 g vertical acceleration)

E′ = SSE load (0.20 g horizontal ground acceleration, 0.133 g vertical acceleration)

3.8.4.1.4 Design and Analysis Procedures

The criteria for Class I structures and equipment with respect to stress levels and load combinations for the postulated events are noted below:

D + R + E[a] Normal allowable code stresses (AISC for structural steel, ACI for reinforced concrete). The customary increase in design stresses, when earthquake loads are considered, is not permitted.

D + R + E′ Stresses are limited to the minimum yield point as a general case. However in a few cases, stresses may exceed yield point. In this case an analysis, using the Limit-Design approach, is made to determine the energy absorption capacity which should be such that it exceeds the energy input. This method has been discussed in the NRC publication TID-7024, "Nuclear Reactor and Earthquakes," Section 5.7. The resulting distortion is limited to assure no loss of function and adequate factor of safety against collapse.

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a Not applicable to Unit 3 corner room structural steel until the structural steel modifications are completed in D3 R14 in contact with the back of the expansion anchor baseplate. Self-drilling expansion anchors which were in contact with the back of the expansion anchor baseplate were either replaced with a wedge-type anchor, or the expansion anchored plate assembly was modified to support the design loads.

Future expansion anchor installations will consist of wedge-type anchors only, with an embedment length equal to eight anchor diameters. These anchors will be installed in accordance with approved QA/QC procedures, and the design load for these anchors will be less than the specified anchor preload.

3.8.4.6.1 INSERT "B"

3.8.5 Non-Class I Structures

3.8-29 Class II structures supporting Class I structures, systems and components were designed to Class II requirements and have been investigated to assure that the integrity of the Class I items is not compromised. Class I structures, systems and components located in Class II structures include the control room, standby gas treatment system, and the standby electrical power systems comprising of the station batteries, diesel generators, essential busses, and other electrical gear for power to critical equipment.

3.8-30 The following structures and systems were designed for Class II rather than Class I because none of them are required for safe shutdown of the plant under conditions of the DBA: the crib house, radioactive waste building and waste disposal system, condensate storage tanks and pumps, reactor building crane, auxiliary power buses, shutdown cooling system, the standby coolant supply system, service water system, fire protection system, and air compressors and receivers.

The containment cooling service water pumps and the emergency diesel generator cooling water pumps are located in Class II structures, but have been afforded Class I protection. The containment cooling service water pumps are located in the turbine building below grade on a reinforced concrete floor above the condensate and condensate booster pumps. The grade floor slab above these pumps protects them from debris and missiles during tornado-type conditions and the floors and surrounding structure in this area have been calculated to be earthquake resistant. The emergency diesel generator cooling water pumps are located at elevation 490'-8" in the crib house. This is the same floor that the circulating water pumps are located on and is below the reinforced concrete slab at grade. The concrete structure of the crib house would not be affected by tornado or earthquakes.

The auxiliary power buses are not required for a safe shutdown of the plant. The diesel generators supply power to the emergency buses which are Class I. The diesel generators and the emergency buses are both totally redundant.

Equipment which requires air from the air compressors and receivers are designed for fail-safe operation should a loss of air occur. Therefore, the air compressors and receivers are not designed to Class I.

Insert "B"

3.8.4.6.1 Interim Operability Criteria

If a concrete expansion anchor assembly is found to exceed the limits provided in 3.8.4.6, it shall be evaluated for operability in accordance with the criteria provided in the SER related to Piping System Operability Criteria issued September 27, 1991.

Table 3.8-11

ALLOWABLE STRESSES FOR CLASS I STRUCTURES

Loading Conditions (3)	Reinforcing Steel Maximum Allowable Stress	Concrete Maximum Allowable Stress: Compression (3)	Concrete Maximum Allowable Stress: Shear	Concrete Maximum Allowable Stress: Bearing	Tension on Net Section (3)	Structural Steel Shear on Gross Section	Compression on Gross Section (3)	Bending (3)
Dead, live, operating, and OBE seismic (0.1 g)	$0.5\ F_y$	$0.45\ f'_c$	$1.1\sqrt{f'_c}$	$0.25\ f'_c$	$0.60\ F_y$	$0.40\ F_y$	Varies with slenderness ratio[2]	$0.66\ F_y$ to $0.60\ F_y$
Dead, live, operating, and wind	$0.667\ F_y$	$0.60\ f'_c$	$1.467\sqrt{f'_c}$	$0.333\ f'_c$	$0.80\ F_y$	$0.53\ F_y$	Varies with slenderness ratio[2]	$0.88\ F_y$ to $0.80\ F_y$
Dead, live, operating, and SSE seismic (0.2 g)	---	[Safe shutdown of the plant can be achieved][1]				---	---	---

F_y = minimum yield point of material f'_c = compressive strength of concrete

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Notes:

1. The structure was analyzed to assure that a proper shutdown can be made during ground motion having twice the intensity of the spectra shown in Figure 3.7-1 even though stresses in some of the materials may exceed the yield point.
2. The slenderness ratio for compression members in ceiling mounted supports for cable trays, conduits, and HVAC ductwork is limited to 300.
3. Not applicable to Unit 3 corner room structural steel until the structural steel modifications are completed in D3R14

In summary, the design of the TAP supports is adequate for the loads, load combinations, and acceptance criteria limits specified in NUREG-0661[5] and substantiates the piping analysis results.

3.9.3-4 INSERT "A"

3.9.4 Control Rod Drive Systems

The design of the CRD system is discussed in Section 4.6. Control rod drive materials are addressed in Section 4.5.

3.9.5 Reactor Pressure Vessel Internals

The following sections provide descriptions of the physical layout of the reactor pressure vessel internals (Section 3.9.5.1), of loading conditions applicable to their structural and functional integrity (Section 3.9.5.2), and of their design evaluation (Section 3.9.5.3). Design of the control rods is described in Section 4.6. Information on the reactor internals materials is provided in Section 4.5.2.

3.9.5.1 Design Arrangements

3.9-48 In addition to the fuel and control rods, reactor vessel internals include the following components:

A. Shroud,

B. Baffle plate (shroud support plate),

C. Baffle plate supports,

D. Fuel support piece,

E. Control rod guide tubes,

F. Core top grid,

G. Core bottom grid,

H. Jet pumps,

I. Feedwater sparger,

J. Core spray spargers,

K. Standby liquid control system sparger,

L. Steam separator assembly,

M. Steam dryer assembly, and

3.9.3.4 Interim Operability Criteria

If a piping system is found to exceed the limits provided in 3.9.3.1.3 and 3.9.3.3, it shall be evaluated for operability in accordance with the SER related to Piping system Operability Criteria issued September 27, 1991.

INSERT "A"

ATTACHMENT E

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

RM Pulsifer Letter to D.L. Farrar, dated May 17, 1996

Question #1:

Does the operability evaluation of the structural steel for the SSE load combination contain all the piping reaction loads, including those due to restraint of free-end expansion of the attached piping?

Response:

Yes. The piping reaction loads include the loads due to the restraint of free-end expansion of the attached piping. The piping reaction loads on the heat exchanger nozzles also include the loads due to restraint of the attached piping. The structural steel is then evaluated for the above loads.

Question #2:

Does the operability evaluation of the structural steel member which transmits the piping load to the building structure allow gross yielding of the structural steel member? If gross yielding is projected, what is the effect on the attached piping or other components?

Response:

No, for the operability evaluation the interaction coefficient for the combination of all of the stress components is less than 1.0. Therefore, gross yielding of the cross section does not occur.

Structural Engineering Branch Request for Additional Information

Question #1:

RG 1.61 damping values in conjunction with the use of relatively non-conservative ground motion input spectrum based on Housner spectral shape are not appropriate.

Response:

As stated in the UFSAR, the Dresden design basis SSE spectra were generated using the El Centro NS time history record scaled to 0.2g. As shown in UFSAR Figure 3.7-1, there is considerable conservatism in the El Centro spectrum compared with the Dresden design response spectrum in the frequency range of interest. Therefore, margin exists in the original design relative to design basis requirements. Furthermore, the NRC SER dated September 27, 1991, states that use of R.G. 1.61 damping is acceptable for interim operability evaluations.

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Question #2:

Provide justification for using the IC method of determining the acceptability when allowable stresses are in the inelastic range (i.e., use of $M_p=F_y*Z$) through text book reference or research papers. For beam B1, provide IC equation using actual numerical values for component fractions. Provide the associated maximum vertical and horizontal deflections.

Response:

Part 1:

The use of linear interaction equations in elastic analysis is the industry practice as defined in Reference 1. In plastic analysis, the strength of the cross section under combined loads is generally determined based on a non-linear interaction equation. It has been demonstrated by testing and theory (Reference 2, Figure 5.17) that the use of linear combination of stress ratios provides a more conservative solution than can be obtained through the use of non-linear equations. The concept of using a linear combination to calculate an interaction coefficient is demonstrated in Code References 1 (Chapter N) and 3 as well as Reference 2 (Equations 5.63 and 5.64).

Part 2: Analysis results for Beam B1 are shown below for load combinations and locations providing the largest IC:

$$IC=\frac{f_a}{F_a}+\frac{f_{bx}}{F_{bx}}+\frac{f_{by}}{F_{by}}+\frac{f_{bw}}{F_{bw}}$$

Where fbw = warping normal stresses due to torsion.

For Unit 2 (24WF68), using the operability criteria:

IC = 0.026 + 0.754 + 0.094 + 0.114

IC = 0.988

For Unit 3 (24WF84), using the UFSAR criteria

IC = 0.012 + 0.897 + 0.0 + 0.0

IC = 0.91

ATTACHMENT E

Part 3: Seismic and Operational Deflections for Beam B1 for Unit 2.

Vertical Deflection:	0.13 inches
Lateral Deflection:	0.04 inches
Longitudinal Deflection:.......	0.03 inches

These deflections are obtained from the linear elastic LMS analysis. Beam B1 connections are assumed pinned at the two ends. The calculated vertical and lateral deflections are thus conservative. Since Beam B1is longitudinally restrained at both ends, there is no significant longitudinal displacement.

The critical connection with respect to longitudinal deformation is Beam 4 of Unit 2. The left end connection of this beam utilizes a hanger arrangement from an embedment plate and thus represents a critical case for the use of yield line analysis of connection components. An evaluation of this connection (Appendix A) demonstrates that the longitudinal deflection of the beam is not significantly affected by the inelastic deformation of the connection.

Question #3:

Provide information regarding the plates in connections 1R, 4L, 11R, and 33R that required the use of the operability strain criterion of 10 times the yield strain.

Response:

Part 1: Allowable Strains

The operability evaluation criteria provides an acceptance criteria for maximum strain of 10 times the yield strain based on the recommendations provided in Table Q1.5.8.1 of ANSI/AISC N690 Revision 1, 1993. This is the same acceptance criteria that was used for the evaluation of the embedment plates at Dresden Units 2 and 3 (References 5 and 6).

For the Dresden corner room steel operability evaluation only localized plastic deformation was found and thus a gross limitation on the yield strain was not required. Appendix A is a simplified calculation of the yield strain for the critical Unit 2 connection (Beam 4 Left). This calculation shows a maximum total strain of 1.26 times the yield strain.

Part 2: Yield Line Theory.

Yield line theory was used to calculate the ultimate bending capacity of connection components. This theory is an acceptable method of calculating the ultimate capacity of plates with an irregular boundary and complicated loading pattern (Reference 4). A factor of safety was applied by using 0.95 times the yield moment as the upper limit on the capacity to ensure that large deformation of the connection does not occur.

ATTACHMENT E

References:

1. AISC ASD 9th Edition.
2. T. V. Galambos, "Structural Members and Frames", Prentice Hall 1968.
3. AISC LRFD 2nd Edition, Chapter H equations H1-1a and H1-1b.
4. Rudolph Szilard, "Theory and Analysis of Plates", Prentice Hall 1974.
5. ComEd Report, "Summary Report Assessment of Embedment Plates", October 16, 1987.
6. NRC SER on Embedment Plates dated October 10, 1988

APPENDIX A TO ATTACHMENT E