ATTACHMENT D

MARKED UP PAGES OF UFSAR

1) Table 3.7-1 Damping Factors for Strong Vibrations Within Elastic Limit
2) Page 3.8-24
3) Page 3.8-29
4) Table 3.8-11 Allowable Stresses for Class I Structures
5) Page 3.9-24 Insert Section 3.9.3.4 - Interim Operability Criteria
6) Insert "A" for Section 3.9.3.4
7) Insert "B" for Section 3.8.4.6.1

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.

a Not applicable to Unit 3 corner room structural steel until the structural steel modifications are completed in D3R14

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	Reinforcing Steel Maximum Allowable Stress (3)	Concrete Maximum Allowable Stress: Compression (3)	Concrete Maximum Allowable Stress: Shear	Concrete Maximum Allowable Stress: Bearing (3)	Tension on Net Section (3)	Structural Steel Shear on Gross Section (3)	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

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"

<u>ATTACHMENT E</u>

<u>RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION</u>

<u>RM Pulsifer Letter to D.L. Farrar, dated May 17, 1996</u>

<u>Question #1</u>:

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?

<u>Response:</u>

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.

<u>Question #2:</u>

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?

<u>Response:</u>

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.

<u>Structural Engineering Branch Request for Additional Information</u>

<u>Question #1:</u>

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.

<u>Response:</u>

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.

ATTACHMENT E

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

Quad Cities Nuclear Station - Units 1 and 2
Dresden Nuclear Station - Units 2 and 3

Response to NRC Questions on the August, 1989,
Piping System Operability Criteria Licensing Submittal

Prepared for:

Nuclear Regulatory Commission

Prepared by:

Commonwealth Edison Company

TABLE OF CONTENTS

Section 1.0

INTRODUCTION

1.0 INTRODUCTION

The purpose of this document is to provide the responses and discussions as requested in the January 11, 1991 letter [1]. Where additional background information has been requested, details are provided in Section 2.0. Where alternative guidance has been suggested, additional discussions are given in Section 2.0 as well as specific changes to the Licensing Submittal, if necessary. A draft Licensing Submittal is given in Section 4.0 for your review.

Section 2.0

RESPONSES TO NRC QUESTIONS

2.1 The use of Regulatory Guide 1.61 damping with original design spectra and analysis procedures is not permitted. Either the FSAR damping should be used or the design spectra and analysis methods for use with current damping should be upgraded. (Section 3.1)

Response:

The use of Regulatory Guide 1.61 damping with the design spectra for operability evaluations was authorized by the NRC during the IEB 79-14 program as well as during the evaluation of the Reactor Recirculation pump snubbers in 1986 (see documentation attached).

The attached letter from R.F. Janacek (CECo) to J.G. Keppler (NRC) on January 5, 1981 [6], explains the background to the use of Regulatory Guide 1.61 damping. For the purposes of this discussion, there are additional references to support the use of R.G. 1.61 damping:

a. The spectra for the SSE load were obtained by multiplying the OBE spectra by 2, with no allowance for the higher damping in the structure during an SSE. Thus, the spectra used for analysis have additional conservatism since the higher damping during the SSE would lower the overall response.

b. The 0.5% damping used for piping was appropriate ".... for strong vibrations within the elastic limit." (Dresden UFSAR, page 12.1.1.-10, attached). This is reasonably consistent with the guidance given in Regulatory Guide 1.61, Position C.3. The proposed stress limit for the design earthquake is twice the elastic limit. Thus, the proposed stress limit supports the use of higher damping values. This is part of the background discussion to the attached 1/5/81 letter.

c. As noted in NUREG/CR-0891, "Seismic Review of Dresden Nuclear Power Station - Unit 2, For The Systematic Evaluation Program," [7] there was considerable margin between the response spectrum from the El Centro time history and the Housner design response spectrum (see Figure 4-3, attached) for periods above about .05 sec. The time history was used in the analysis of the reactor-turbine building.

These three points are presented only as additional references. The primary reason for the proposal of Regulatory Guide 1.61 damping is the prior acceptance based on evidence presented during the IEB 79-14 time frame.

IMPELL

Record of Conversation

File: 0590-144

Copy: FSStoller
JCMinichiello
RWheaton
AHo
RMirochna
SJavidan
TTWittig

___Telephone ✓ Meeting ___Other

To: NRC Staff
(See enclosed attendance list)

From: CECo and Impell

Company: Commonwealth Edison **Phone No.:** **Date:** 5/13/86

Subject: Dresden, Quad Cities, and LaSalle Piping Criteria and Methodologies

Summary of Conversation:

The NRC Staff requested this meeting to discuss piping criteria and methodologies for the subject plants. Relative the D/QC, the purpose of the meeting was to discuss appropriate criteria for evaluating loads on the Recirc. System pump snubbers. Included in the D/QC discussions were CECo's September 1985 submittal which contained a proposed set of comprehensive and consistent criteria for piping systems.

For LaSalle, the principal topic was criteria for the snubber reduction program at Units 1 and 2.

Handouts from the meeting are attached. Conclusions and resolutions are listed below:

- The NRC voiced several reservations about using PVRC (ASME Code Case N-411). In no particular order of importance, they were: (1) use on older plants like Dresden and Quad; (2) use with IGSCC susceptable piping; (3) use with older methodologies; (4) use with older seismic input; (5) use with OBE. Each of these issues is still under review by the Staff.

- No NRC decision on D/QC. BD Liaw, BWR Chief of Engineering, adamately insisted that there could be no resolution on criteria independent of the SEP issues on D2. As a result, it was suggested that CECo prepare a revised criteria which integrated SEP. This was left unresolved.

- In response to our table which showed a comparison between FSAR and submittal techniques (both using PVRC damping), the Staff expressed concern with certain methods which were not addressed

in the FSAR, such as consideration of missing mass. They were also concerned about the combination of two directions of earthquake which is the FSAR's directional combination method.

- The Staff recommended an alternative to the submittal methods. They suggested that RG 1.61 damping be used with FSAR techniques. CECo agreed to use this technique to reevaluate the D2 pump snubbers. If this approach was insufficient, the Staff recommended further discussions.

- On LaSalle, the Staff rejected most of the proposed techniques. They did provide authorization for PVRC damping and for some reevalution of load combinations. The latter required a safety evaluation (50.59).

- CECo received tentative authorization from R. LaGrange to use direct generation techniques to develop in-structure spectra for additional damping values.

Action items resulting from this meeting were:

1. Impell to reanalyze the Recirculation System pump snubbers for Dresden Unit 2 using RG 1.61 damping with FSAR techniques. Needed spectra will be developed using direct generation techniques. Impell agreed to complete D2 on 5/14.

2. Impell should be prepared to discuss why 79-14 did not identify the dimensional verification decrepancies noted during the walkdowns in 1985 which ultimately led to the issuance of the September submittal. Impell agreed to be ready on 5/14.

3. Impell to be prepared to discuss why 79-14 did not address the Recirc. Pump supports. Impell agreed to be prepare on 5/14.

Piping Criteria and Methodologies
Dresden, Quad Cities, and LaSalle
May 13, 1986

Attendees:

R. Gilbert	NRC/DBL/BWD#1
M. Turrak	CECo - Nuclear Licensing
R. Wheaton	Impell
J. Minichiello	Impell
S. Javidan	CECo - SNED
J. Wojnarowski	CECo - Nuclear Licensing
T. Wittig	Impell
C. Allen	CECo - Nuclear Licensing
A. Bournia	NRC/DBL/BWD#3
Y. Li	NRC/DRL/EB
H. Shaw	NRC/DBL/EB
J. Fair	NRC/IE
R. LaGrange	NRC/NRR/DBL/EB
G. Bagchi	NRC/NRR/PWRA/EB
R. Riggs	NRC/NRR/PWRA/EB
B. Liaw	NRC/NRR/DBL/EB
E. Adensam	NRC/NRR/DBL/BWD3
D. Farrar	CECo - Nuclear Licensing
G. Kitz	Sargent & Lundy
R. Srinivasan	CECo - Consultant/S. Levy, Inc.
J. Marianyi	CECo - SNED
J. Fox	CECo - SNED
R. Bosnak	NRC/DSRO/EIB
M. Hartzman	NRC/NRR/PWR-B/EB
G. Lainas	NRC/NRR/DBL
R. Bevan	NRC/NRR/DBL/BWD#1
J. Zwolinski	NRC/NRR/DBL/BWD#1
R. Bernero	NRC/NRR/DBL

This curve is the upper curve shown in Figure 12.1.1:2. Since the unsmoothed curve is generated from the time-history record and the smooth response spectrum curve has lower accelerations for nearly all periods, it is concluded that the time-history method tends to over-estimate the response when compared to the design criteria (smooth response spectrum). It is reiterated that the two methods of analysis used at Dresden were the time history and the smooth response spectrum, and it is our firm opinion that the responses calculated by these methods are conservative.

The seismic consultant prepared the acceleration response spectrum curves shown in Figures 12.1.1:3 and 12.1.1:4 based upon a ground acceleration of 0.1g. The seismic design of Class I structures and equipment was based upon a dynamic analysis using these curves. The natural periods of vibration were calculated for buildings which are vital to the proper shutdown of the plant. The following damping factors were used for strong vibrations within the elastic limit:

Item	% 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

For the design of Class I structures and equipment the maximum horizontal acceleration and the maximum vertical acceleration were considered to act simultaneously. Where applicable the resulting seismic stresses for the two motions were combined linearly. The vertical acceleration assumed was equal to 0.067g, 2/3 the horizontal ground acceleration.

To assure that the plant can be shut down with containment and heat removal facilities intact, Class I structures have been designed to accommodate a ground motion of 0.2g. Care was taken to assure that structures will not fail in a brittle manner.

The results of the seismic analysis were used in the design of the associated Class I structures, systems, and components. For the seismic analysis of equipment absolute acceleration is used at the points of support. Where a dynamic analysis was not performed the horizontal seismic coefficients for rigid Class I equipment in the reactor turbine building are equal to or greater than the building acceleration at the installed elevation. The vertical seismic coefficient is equal to 2/3 ground acceleration or 0.067g. Flexible and rigid Class I piping systems are analyzed as described in section 12.1.2.4.

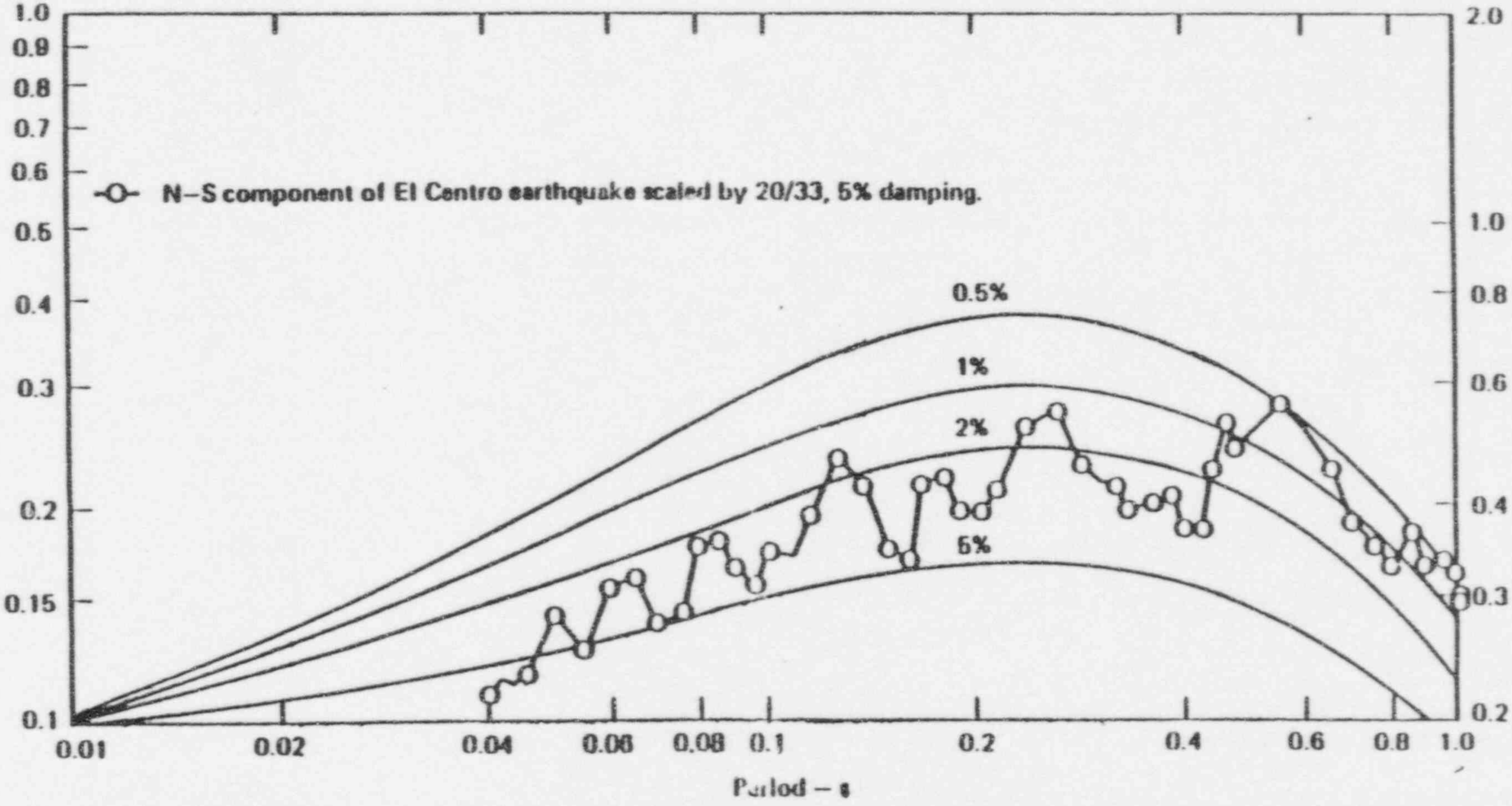


FIG. 4-3. Comparison of Housner design response spectra and response spectrum for El Centro earthquake, 5/18/40 N-S component (Source: Refs. 7 and 10).

3. Nonlinear analysis of the "worst case" system in order to determine a more realistic assessment of the margin of safety than exists in the original project acceptance criteria and how that margin can be used as the basis for revised criteria.

Based on these evaluations and review of all systems in the Quad-Cities Unit 1 plant, EDS has developed revised initial acceptance criteria.

The basic criterion that EDS uses for piping analysis is as follows:

$$\sigma_{SSE} + \sigma_g + \sigma_p < 2\sigma_y$$

for all carbon steel piping. The criteria for stainless steel differ slightly and are established as follows:

1. $\sigma_{SSE} + \sigma_g < 2\sigma_y$

As assurance that a buckling mode will not occur and hence prevent flow, and

2. $\sigma_{SSE} + \sigma_g + \sigma_p < 2.2\ \sigma_y$

The calculation of stresses due to an SSE will be made using a damping value of 2% which is more suitable for such an event and is supported by R.G. 1.60. It is further supported by the refined linear analysis that we have performed.

The second criterion adopted for stainless steel piping is appropriate for the following reasons:

1. Yield properties for stainless steel are at least 10% greater than those listed in the code.

2. There is a far greater margin between ultimate strength and yield strength for stainless steel. This justifies the distinction between a strain limiting criterion, tied to ultimate stress. Since the pressure stress contributes to the latter type of failure, but not the former, it should be included in the latter only.

2.2 The primary stress limits for normal and faulted condition loads exceed ASME Code (Code) allowables but are consistent with limits accepted by NRC for interim operation of other plants. However, secondary stress limits (e.g., on thermal stresses and seismic anchor motions) are not addressed. These limits should be defined and justifications provided if they exceed Code allowables. (Section 3.1)

Response:

The criteria will be revised to state that piping secondary stresses shall be evaluated against the existing FSAR/UFSAR allowables.

Note that the evaluation of piping secondary stresses will not include anchor motion (secondary stresses) due to earthquake. Since evaluation of the OBE load case is not part of the operability evaluation (see response to question 2.3), only the low probability SSE load case (one occurrence assumed per design) remains. Not including a one-time occurring load case in a secondary stress evaluation is consistent with current ASME philosophy.

Loads on supports due to SSE anchor motions will be included in the operability evaluation of the supports (see Section 4.0).

2.3 The criteria does not provide pipe stress limits for operating basis earthquake (OBE) and other occasional loads including waterhammer or steamhammer. These limits should be defined and if they exceed Code allowables, the actions that would be taken to assure continued operability should be explained. (Section 3.1)

Response:

The operability criteria does not provide pipe stress limits for OBE since limiting sustained plus SSE pipe stresses to $2S_y$ already ensures piping system operability and that safe shutdown can occur. This is because the SSE response spectra (at 2% damping) always envelopes the OBE response spectra (at 1% damping). The primary reason that SSE always envelopes OBE at their corresponding Regulatory Guide 1.61 damping values is that SSE originally was defined as twice OBE without allowance for the higher structural damping during as SSE (see response to question 2.1). As a further demonstration of this fact, the attached page A-12 from the Dresden Seismic Design Document has been marked-up to compare SSE at 2% damping to OBE at 0.5% damping. In this example, the SSE response spectra even envelopes the OBE response spectra at 0.5%.

The proposed operability criteria has been clarified with respect to other occasional loads such as waterhammer or steamhammer to require that they be combined with SSE (per FSAR/UFSAR load combinations) and the results shall be less than $2S_y$.

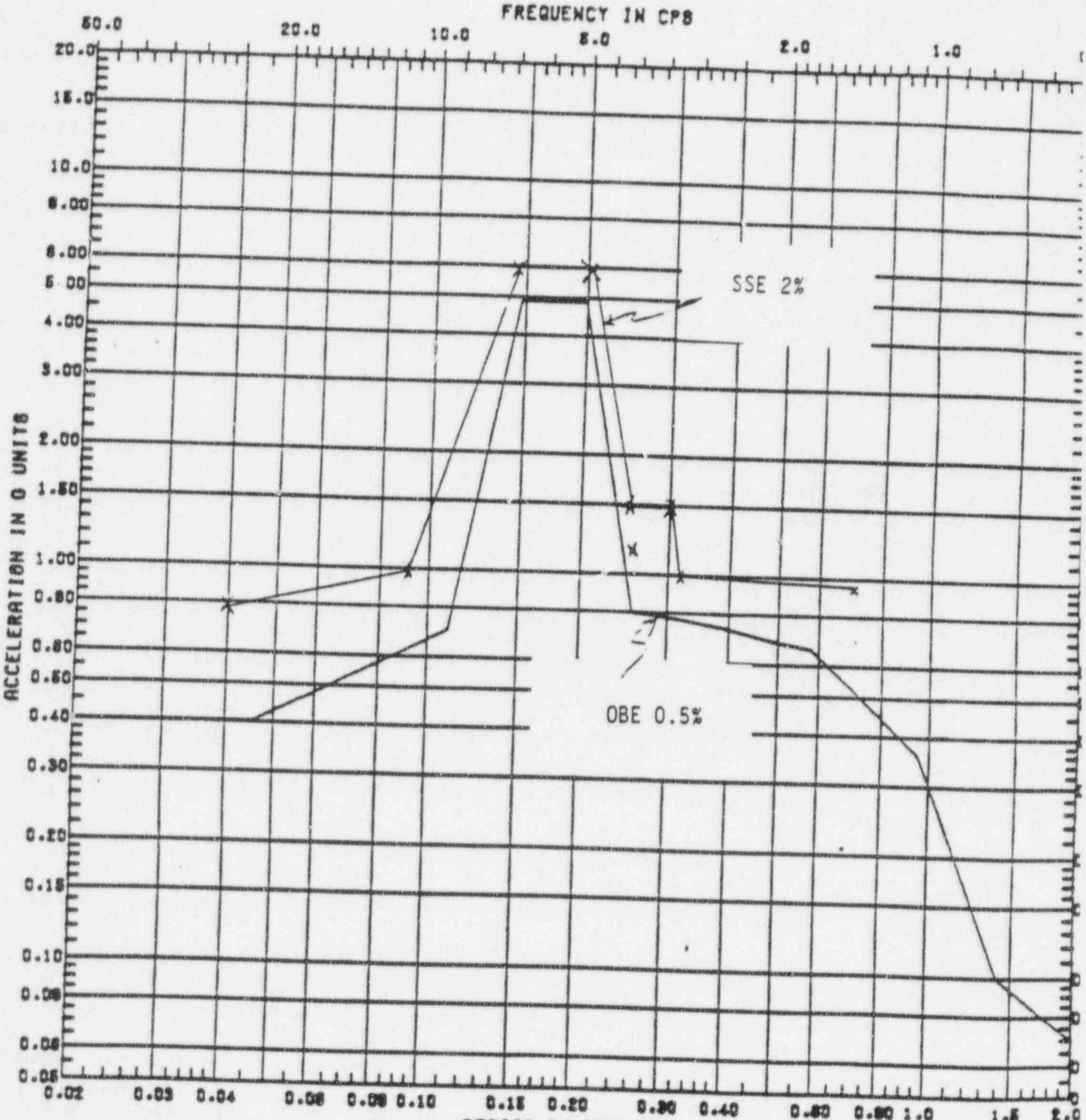
SARGENT & LUNDY
ENGINEERS

09 OCT 85

S574YW

DC-SE-002-DR
REVISION 1
MARCH 31, 1987

CALC NO. 7355-E8-8 SAFETY RELAT
PROJECT DRESDEN UNITS 2&3
PROJECT NO. 7355
DAMPING 0.005
PAGE: A-12



SEISMIC SPECTRA - OBE

NODE 5

DIRECTION N-S

ELEVATION 589'-0"

LOCATION REACTOR BUILDING

1

2.4 The criteria for flanges needs to be clarified. If faulted condition limits will be applied to normal load combinations, further justification should be provided. (Section 3.2.1)

Response:

Flanges shall meet standard requirements of the piping codes referenced in the FSAR/UFSAR with the exception that OBE will not be included (see response to question 2.3). The criteria will be revised to clarify this point.

2.5 The licensee should provide the current design criteria for piping deflections and explain how it will ensure against interactions with adjacent structures when used in conjunction with the proposed operability criteria. (Section 3.2.2)

Response:

The current criteria for piping deflections is given in the attached page of the Quad Cities UFSAR [2] and the attached page of the Quad Cities FSAR [8]. Piping deflections less than 4 inches are considered acceptable with no further justification. For instances where the calculated deflections exceed these criteria, walkdowns shall be performed to determine if there is a potential for interactions with other plant items. If no potential interactions are found, this proposed piping operability criteria may be used. However, if interactions need to be evaluated, the evaluation of these interactions and the determination of piping operability is beyond the scope of these piping operability criteria.

For Class I systems, the boundaries of the piping system model used in the seismic analysis extends well beyond the stress analysis boundaries set by the first normally closed valves.

This is done to provide confidence that the dynamic loading influence of the Class I piping outside of (but attached to) the critical Class I portion of the system model is adequately accounted for.

Three systems were dynamically analyzed by GE consultants: the recirculation piping, and Class I portions of the main steam and the feedwater systems. The number of modes considered depends upon the particular system configuration. For the three systems, respectively, the number of modes utilized are six, seven, and twelve. The remaining Class I piping systems, 10 inches in diameter and larger, were dynamically analyzed by the architect-engineer using the response spectra method of dynamic analyses.

The dynamic response of the piping system was analyzed by the DYNAPIPE computer program (S&L Propietary Program). The program accounts for the effects of bending, shear, torsion, and axial deformations.

All dynamic analyses used 1/2-percent of critical damping for both the OBE and DBE except for the standby gas treatment system, where 1-percent of critical damping was used.

It is possible that seismic stresses may be relatively low in a system and the seismic deflections are large, i.e., on the order of 4 or more inches. When such is the case, clearances were checked to insure that the piping will not be damaged by striking any nearby structure, component, etc.

Vibrations

12.2.2.7 Piping Systems

The Class I piping systems, as noted previously, are analyzed to assure compliance with the criteria by one of two methods: dynamic or force-deflection curves. Dynamically analyzed systems utilize the computerized response spectra method. In this method the piping is modeled by a series of discrete masses interconnected by weightless springs. The system is then subjected to a translatory motion in each of the three mutually perpendicular directions of the global axis system. The program utilizes the appropriate floor response spectra to determine appropriate spectral accelerations after computation of the mode frequencies and shapes. One half percent damping factor is used on piping. For each mode the displacements and inertia forces are determined and the inertia forces of each mode are used as an external loading condition. The total combined modal results are obtained by taking the square root of the sum of the squares for each parameter, i.e., moments, shears, and displacements. In addition to the items noted, the computer program accounts for the effects of curved members and elbows by use of stress intensification factors which are functions of the pipe diameter, thickness, and bend radius.

Three systems were dynamically analyzed by GE consultants: the recirculation piping, and Class I portions of the main steam and the feedwater systems. The number of modes considered depends upon the particular system configuration. For the three systems, respectively, the number of modes utilized are six, seven, and twelve. The remaining Class I piping systems, 10 inches in diameter and larger, were dynamically analyzed by the architect-engineer using the response spectra method of dynamic analyses.

A more detailed discussion of the methods has been presented on the Dresden AEC Docket 50-237 and 50-249, Amendments 20 and 21. The method discussed as "Method II" in that reference is the method employed for all of the Quad-Cities dynamic analyses. Maximum stresses determined at Quad-Cities are similar to those shown on the Dresden Docket, Amendments 20 and 21. Twice the design values were reviewed to assure criteria compliance.

Class I piping that is under 10 inches in diameter is analyzed by the force-deflection curve method. This method is identical to that described in the previously referenced Dresden AEC amendments. In summary, this method utilizes a set of curves to place horizontal restraints in a manner which limits stresses to acceptable values. The piping section period is checked to ascertain if the system is rigid, resonant, or flexible in relation to the building. The resonant range (piping period 0.08 to 0.23 second by definition) is avoided in selection of spans. A factor of 3 is applied to deflections and reactions if the piping is flexible and the pipe is more than 25 feet above the foundation in order to account for building amplification. Valves and branch connections are considered by limiting spans to the rigid category and then reducing the allowable spans by a factor of two, and 33% of the additional weights are added to reactions to account for this increased loading. Deflections and loadings determined for the family of curves are based on the ground acceleration spectra with 0.5% damping. A significant feature of the curves is that deflections are limited to values that will exceed 2 inches or will not result in stresses greater than 3700 psi. The results are reviewed to ensure that double these loadings, combined with the normal operating loads, will not result in a stress greater than yield of the piping material. The technique is used on the multitude of Class I, 8-inch and smaller lines such as the instrument lines.

2.6 The pipe support loads and analysis methods appear consistent with those accepted by NRC for interim operation at other plants. To ensure proper implementation, some examples to illustrate the method, including how the worst case failure mode of a support would be incorporated into the analysis, should be provided. (Section 4.0)

Response:

The criteria has been revised to state the following:

"Should the support stresses not meet their operability limits, then additional iterative analyses of the piping may be required. The iterative analyses may use the knowledge that a support is not capable of withstanding the loads, and can be removed from the analysis. Where feasible, the actual support stiffness may be included in the iterative analyses."

Example:

An operability analysis is performed on a system containing three supports (A, B, and C) and it is discovered that support A is not capable of withstanding the loads. The first analysis assumes support A is active and results in loads on supports B and C of 100 lbs. and 200 lbs., respectively. The second analysis assumes support A is inactive and results in loads on supports B and C of 80 lbs. and 400 lbs., respectively. The envelope loads for supports B and C of 100 lbs. and 400 lbs., respectively would be used to determine the stresses in supports B and C.

2.7 For standard supports with manufacturer's load rating, the criteria are similar to those accepted by NRC for interim operation at other plants. However, the technical basis for the safety factors on ultimate test loads and for the multiplier of 1.67 S_u/S_y on Level A allowables is unknown and should be provided. If based on ASME Code, the applicable Code edition and subsection should be referenced. (Section 4.1.1)

Response:

The factor of safety of 2 is from IEB 79-02 [4]. For u-bolts, a more conservative factor of safety of 3 is used since test results indicate u-bolt lateral deflections increase quickly at loadings greater than about half of the ultimate load.

The 1.167 S_u/S_y factor on Level A loads is from Regulatory Guide 1.124 [5]. Actually, the criteria is more restrictive since Regulatory Guide 1.124 allows the factor to be 1.4 if $S_u \leq 1.2\ S_y$. However, to ensure consistency between Regulatory Guide 1.124 and the criteria, the Regulatory Guide 1.124 criteria will be incorporated in its entirety as follows:

".... the smaller factor of 2 or 1.167 S_u/S_y, if $S_u > 1.2S_y$ or 1.4 if $S_u \leq 1.2S_y$."

A reference to IEB 79-02 and Regulatory Guide 1.124 will be added to the criteria.

2.8 The structural steel stress limits are very similar to those accepted by NRC at other plants. However, the proposed use of actual yield strengths based on certified material test reports (CMTRs) is generally not acceptable. Their use would further reduce safety factors to levels which may be unacceptable for even interim operation. The use of Code minimum yield strengths is appropriate. (Section 4.2.1)

Response:

The criteria will be revised to only allow the use of code values for S_u and S_y.

2.9 The snubber load limits are consistent with other NRC accepted interim criteria. However, the snubber criteria should also include a requirement that calculated movements do not exceed the travel range. (Section 4.3.2)

Response:

The following statement will be added:

"Snubbers shall also be reviewed to ensure they can accommodate thermal movements without exceeding travel limits."

Section 3.0

REFERENCES

3.0 REFERENCES

[1] NRC Letter from Byron Siegel/Leonard N. Olshan to Thomas J. Kovach (CECo), dated January 11, 1991.

[2] Quad Cities UFSAR, Section 12.2.2.7.

[3] Impell Record of Conversation to the NRC from CECo and Impell, dated May 13, 1986, Impell Job No. 0590-144.

[4] IE Bulletin No. 79-02, Revision No. 1, (Supplement No. 1), dated August 20, 1979.

[5] Regulatory Guide 1.124, "Service Limits and Loading Combinations for Class 1 Linear-Type Component Supports," Revision 1, January 1978.

[6] Commonwealth Edison Company letter from Robert F. Janecek to James G. Keppler (NRC) "Dresden Station Units 2 and 3, Quad Cities Station Units 1 and 2, Additional Responses Concerning IE Bulletin 79-14", dated January 5, 1981.

[7] NUREG/CR-0891, "Seismic Review of Dresden Nuclear Power Station - Unit 2 for the Systematic Evaluation Program."

[8] Quad Cities FSAR, Section 12.2.7.

Section 4.0

DRAFT LICENSING SUBMITTAL

APPENDIX A TO ATTACHMENT E

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APPENDIX A

COMMONWEALTH EDISON COMPANY
CALCULATION REVISION PAGE

CALCULATION NO. 9389-04-D2-SW PAGE NO.: 1.3.2

REV: 0 STATUS: Approved QA SERIAL NO. OR CHRON NO. DATE:

PREPARED BY: [signature] DATE: 3/1/96

REVISION SUMMARY:

Functional Evaluation for the Dresden Units 2 & 3 LPCI Corner Room Structural Steel

Added Section 18 - page 18.1

pages 18.2.1-18.2.12	pages 18.8.1-18.8.5	18.3.A1-18.3.A13
pages 18.3.1-18.3.9	pages 18.9.1-18.9.12	18.3.B1-18.3.B13
pages 18.4.1-18.4.8	pages 18.10.1-18.10.2	18.4.A1-18.4.A5
pages 18.5.1-18.5.51	pages 18.11.1-18.11.2	18.9.A1-18.9.A3
pages 18.6.1-18.6.6	pages 18.12.1-18.12.3	18.9.B1-18.9.B4
page 18.7.1-18.7.62	page 18.10.A1	18.11.A1-18.11.A2

ELECTRONIC CALCULATION DATA FILES REVISED:

(Name ext/size/date/hour: min/verification method/remarks)

c:\D2SWLMS\7%NOZPA.RSA 1,092,289 bytes 02/27/96 18:35:56

DO ANY ASSUMPTIONS IN THIS CALCULATION REQUIRE LATER VERIFICATION? YES ___ NO X

REVIEWED BY: [signature] DATE: 3/1/96

REVIEW METHOD: Detailed COMMENTS (C OR NC): NC

APPROVED BY: C. W. Petropoulos DATE: 3/1/96

REV: 0 STATUS: APPROVED QA SERIAL NO. OR CHRON NO. DATE:

PREPARED BY: [signature] DATE: 5/21/96

REVISION SUMMARY:

ADDITIONAL CALCULATION FOR DRE-U2 B4 LEFT CONN.

ADDED PAGES 18.5.10.1 - 18.5.10.5 , REVISED PG 18.1.1

ELECTRONIC CALCULATION DATA FILES REVISED:

(Name ext/size/date/hour: min/verification method/remarks)

DO ANY ASSUMPTIONS IN THIS CALCULATION REQUIRE LATER VERIFICATION? YES ___ NO X

REVIEWED BY: T. G. Manda DATE: 5/21/92

REVIEW METHOD: DETAILED COMMENTS (C OR NC): NC

APPROVED BY: T. J. Behringer DATE: 5/21/96

file: c:\bart\wpf_calc\lpci_dcs.wpf

Purpose

To ensure compatibility of the analysis methodology with the connection behavior this connection was performed to determine the strain level and deflection in connection angles at connection B4L. This connection was chosen as it has the highest local angle bending interaction ratio of the Dresden Unit 2 connections that used yield line analysis in the corner room operability evaluation. The other connection that used yield line analysis (B11R) has a local connection bending ratio of 0.69. Connection B4L has a local bending ratio of 0.83. Connections B1R and B33R do not use yield line analysis.

References:

1. Timoshenko & Gere, "Mechanics of Materials", D. Van Nostrand, 1972
2. Calc 9389-04-D2-SW pp. 18.5.1-18.5.10

Methodology

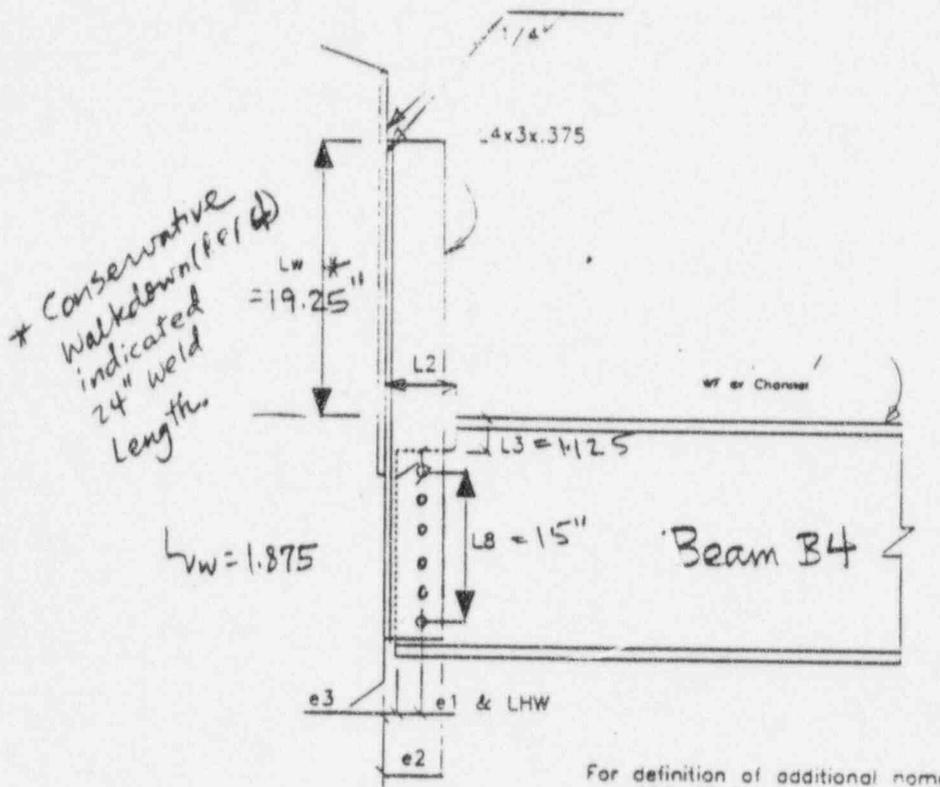
Use Ref. 1 to compute the inelastic strain and deflection in the connection angle.

Note: This calc is an extension of Ref. 2 calc, variables carried over from Ref. 2 are:

$Fy = 36 \cdot ksi$	Yield Strength
$t = 0.38 \cdot in$	Angle thickness
$m_p = 1.27 \cdot \frac{kip \cdot in}{in}$	Plastic capacity of the angle leg
$r1 = 0.83$	Local bending IC of the connection angle using yield line analysis at 0.95 mp
$a = 2.25 \cdot in$	Connection angle parameters (See Ref. 2)
$b = 19.25 \cdot in$	

COMMONWEALTH EDISON COMPANY

CALCULATION NO. 9389-04-D2-SW	PROJECT NO. 9389-04 (9630-66)	PAGE NO. 18.5.10.2
REVISION NO. 0		
PREPARED BY: S J Chhabra DATE: 5/21/96	REVIEWED BY: [signature]	DATE: 5/21/96



For definition of additional nomenclature, see SDS-E7 Detail 7.10.2.

B4L.MCD 2/29/96 p 1

Connection B4L

COMMONWEALTH EDISON COMPANY

CALCULATION NO. 9389-04-D2-SW	PROJECT NO. 9389-04 (9630-66)	PAGE NO. 18.5.10.3
REVISION NO. 0		
PREPARED BY: S J Chhabra DATE: 5/21/96	REVIEWED BY: [signature]	DATE: 5/21/96

Solution

Compute extreme fiber strain in the connection angle at the yield line:

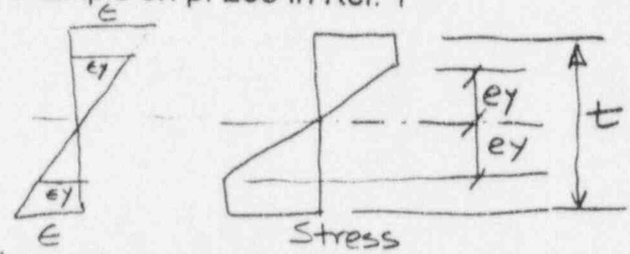
The moment along the yield line based on the interaction ratio r1 of the clip angle:

$$m_{YL} := 0.95 \cdot r1 \cdot m_p$$

$$m_{YL} = 0.79 \cdot m_p$$

For a partially yielded section the moment is

$$m(ey) := \frac{Fy \cdot t^2}{6} \cdot \left(\frac{3}{2} - \frac{2 \cdot ey^2}{t^2}\right)$$ equation c in example on p. 295 in Ref. 1



Find ey:

$ey := 0.01 \cdot in$ seed

$ey := root(m_{YL} - m(ey), ey)$ mathcad function root used to solve for ey.

$ey = 0.15 \cdot in$ $ey = 0.4 \cdot t$

Check the solution:

$m(ey) = 0.79 \cdot m_p$ OK

Now using the linear strain diagram, the strain at the extreme fiber is computed as follows

$$E := 29000 \cdot ksi$$

$\varepsilon_y := \frac{Fy}{E}$ $\varepsilon_y = 0.0012$ Yield Strain

$\varepsilon(ey) := \varepsilon_y \cdot \left(\frac{0.5 \cdot t}{ey}\right)$ $\varepsilon(ey) = 1.26 \cdot \varepsilon_y$

Compute inelastic deflection of the clip angle at the load point:

$L := h$

$L = 2.58 \cdot in$ Cantilever Length -- load point to yield line distance

$bw := \sqrt{a^2 + b^2}$

$bw = 19.38 \cdot in$ Cantilever width

$m_y := \frac{bw \cdot t^2}{6} \cdot Fy$

$m_y = 16.35 \cdot kip \cdot in$ First Yield Moment

$Py := \frac{m_y}{L}$

$Py = 6.33 \cdot kips$ First Yield Load

$Ix := \frac{bw \cdot t^3}{12}$

$\delta_y := \frac{Py \cdot L^3}{3 \cdot E \cdot Ix}$ $\delta_y = 0.015 \cdot in$ First Yield Displacement at load point

Using the equation (h) in example on p. 308 of Ref 1

$Rz = 15 \cdot kips$

$$\delta(P) := \delta_y \cdot \left(\frac{Py}{P}\right)^2 \cdot \left[5 - \left(3 + \frac{P}{Py}\right) \cdot \sqrt{\left(3 - \frac{2 \cdot P}{Py}\right)}\right]$$

$\delta\left(\frac{Rz}{2}\right) = 0.0176 \cdot in$ Half Rz is the load on each connection angle

$\delta\left(\frac{Rz}{2}\right) = 1.19 \cdot \delta_y$ Deflection is small

Also compute elastic deflection of the hanging connection angles at the c.g. of the bolt group:

$L := \left(\frac{15}{2} + 1.1875 + 1.125\right) \cdot in$ Cantilever length (from bolt c.g. to the bottom of weld)

$Ixx := 5.54 \cdot in^4$ 2L 4x3x0.375 Long leg back to back

$$\delta e := \frac{Rz \cdot L^3}{3 \cdot E \cdot Ixx}$$

$\delta e = 0.029 \cdot in$ Small

Conclusion

These deflections and strain are small and therefore should not affect the functionality of pipe supports M-3204-07A, M-3214-26A and M-3214-26B that are attached to this beam.

COMMONWEALTH EDISON COMPANY

CALCULATION NO. 9389-04-D2-SW	PROJECT NO. 9389-04 (9630-66)	PAGE NO. 18.5.1
REVISION NO. 0		
PREPARED BY: S J Chhabra DATE: 2/29/96	REVIEWED BY: Alan Lo DATE: 2/29/96	

Purpose:
Determine the functional status of the connection B4L.

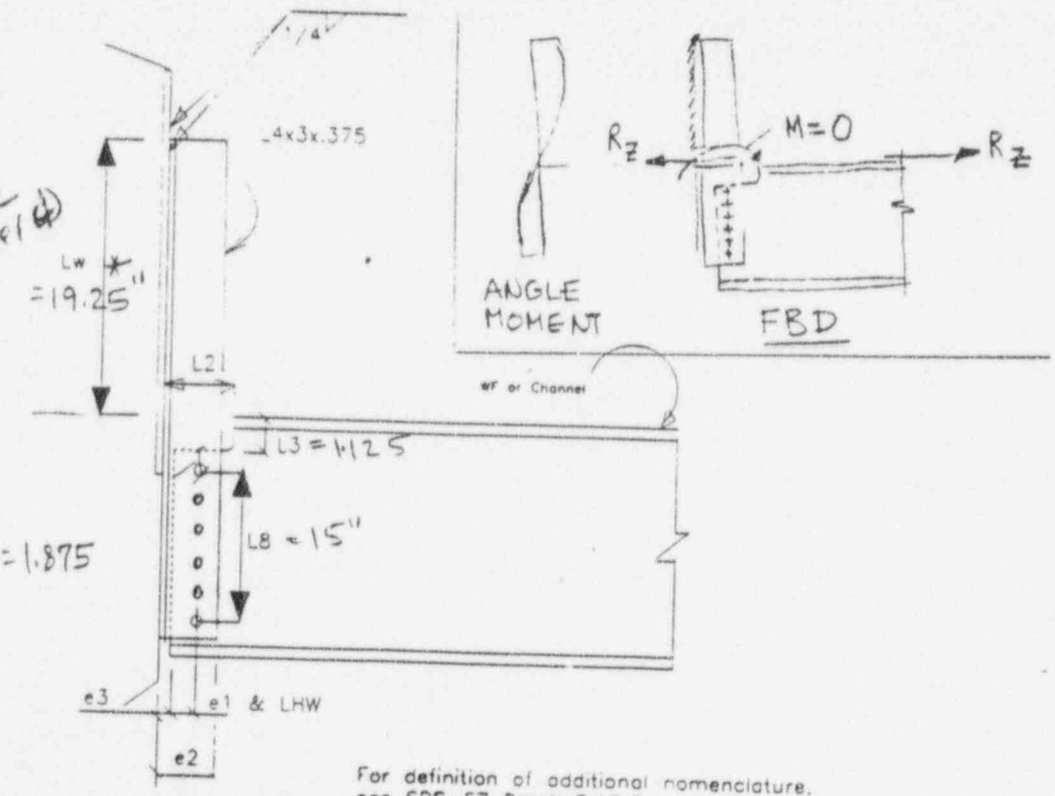
References:

1. LRFD Manual, Volume I, 2nd Edition
2. LRFD Manual, Volume II, Connections, 2nd Edition
3. Old calcs performed in April 1994 by BB Slimp
4. Walkdown info for vertical weld length at the embed plate
5. AWS D1.1, Chapter 10, 1990
6. LMS Output Dated 2/27/96 18:35:56

Methodology:

Model For Computing the Angle Bending Allowable For Rz Load:

Since the Heat Exchanger tank is supported by the the top flange of beam B4, the following free body diagram is used to show that the point of zero moment in the connection angles is at a cross section taken at the top of beam flange. This model indicates that the critical section for angle bending will be at or below the top bolt hole, depending upon the distribution of the reaction in the bolts. The sections above the zero shear section are not critical because the angle, at these locations, is welded to 3/4" embed plate, and the composite section between the embed plate and the angles has significantly higher section properties than the angles alone.



For definition of additional nomenclature, see SDS-E7 Detail 7.10.2.

E/2

COMMONWEALTH EDISON COMPANY

CALCULATION NO. 9389-04-D2-SW | PROJECT NO. 9389-04 (9630-66) | PAGE NO. B.5.2

REVISION NO. 0 | | | |

PREPARED BY: S J Chhabra DATE: 2/29/96 | REVIEWED BY: [signature] DATE: 2/29/96

Loads per Ref. 6:

$Ry = 27 \cdot kips$ $Rz = 15 \cdot kips$ $Mz = 1.2 \cdot kip \cdot ft$ $Rx = 0.64 \cdot kips$ ✓

Other Data:

$Fy = 36 \cdot ksi$ Yield Strength

$Ag = 4.96 \cdot in^2$ Gross area of the double angle

$ry = 1.31 \cdot in$ Radius of gyration of double angle about an axis parallel to instanding leg

$tw = 0.375 \cdot in$ web thickness of beam

$Nb = 6$ Number of bolts

$pitch = 3. \cdot in$ Bolt pitch

$L8 = (Nb - 1) \cdot pitch$ $L8 = 15 \cdot in$ L8 Dimension

$$Ib = \sum_{n=1}^{Nb} \left[\frac{Nb-1}{2} \cdot pitch - (n-1) \cdot pitch \right]^2$$ Moment of Inertia of a line of bolts.

$Ib = 157.5 \cdot in^2$

$Sbolts = \frac{Ib}{0.5 \cdot L8}$ $Sbolts = 21 \cdot in$

COMMONWEALTH EDISON COMPANY

CALCULATION NO. 9389-04-D2-SW	PROJECT NO. 9389-04 (9630-66)	PAGE NO. 18.5.7
REVISION NO. 0		
PREPARED BY: S J Chhabra DATE: 2/29/96	REVIEWED BY: [signature]	DATE: 2/29/96

Shear in bolts 1, 2 and 6 (numbered from top down):

$Vb\_1 = \frac{Rz}{Nb} + \frac{Rz \cdot 10.5 \cdot in}{Sbolts}$ $Vb\_1 = 10 \cdot kips$ Shear in bolt 1

$Vb\_2 = \frac{Rz}{Nb} + \frac{Rz \cdot 10.5 \cdot in}{Ib} \cdot \left(\frac{L8}{2} - pitch\right)$ $Vb\_2 = 7 \cdot kips$ Shear in bolt 2

$Vb\_6 = \frac{Rz}{Nb} - \frac{Rz \cdot 10.5 \cdot in}{Sbolts}$ $Vb\_6 = -5 \cdot kips$ Shear in bolt 6

Slip load allowable under SSE for these bolts is about 18 kips (1.6*12.03 per Calcs for connection B11R). Thus, no slip is expected, thus model assumed to calculate angle bending is OK.

Max moment in the angle will occur at bolt number 2 (point of zero shear):

$Mangle = Rz \cdot 6 \cdot in - Vb\_1 \cdot 3 \cdot in$

$Mangle = 60 \cdot kip \cdot in$

$Sxnet = 1.972 \cdot in^3$ From old Calcs, Ref 2

$SF = 1.5$ Shape Factor; real shape factor is larger but may be harder to attain.

$fbx = \frac{Mangle}{SF \cdot Sxnet}$ $fbx = 20.28 \cdot ksi$

$ARZ_{OP\_BEND\_ANG} = \frac{Rz}{fbx} \cdot (0.95 \cdot Fy)$

$ARZ_{OP\_BEND\_ANG} = 25.29 \cdot kips$

$ARY_{OP\_BEND\_ANG} = 0.95 \cdot Fy \cdot Ag$

$ARY_{OP\_BEND\_ANG} = 169.63 \cdot kips$

Mz Capacity:

This load causes moment about the y axis of the double angle (y axis is parallel to the instanding leg of the connection angle):

$ry = 1.31 \cdot in$ $\qquad Ag = 4.96 \cdot in^2$

$xb := 3 \cdot in - 0.5 \cdot tw$ extreme fiber distance

$xb = 3.19 \cdot in$

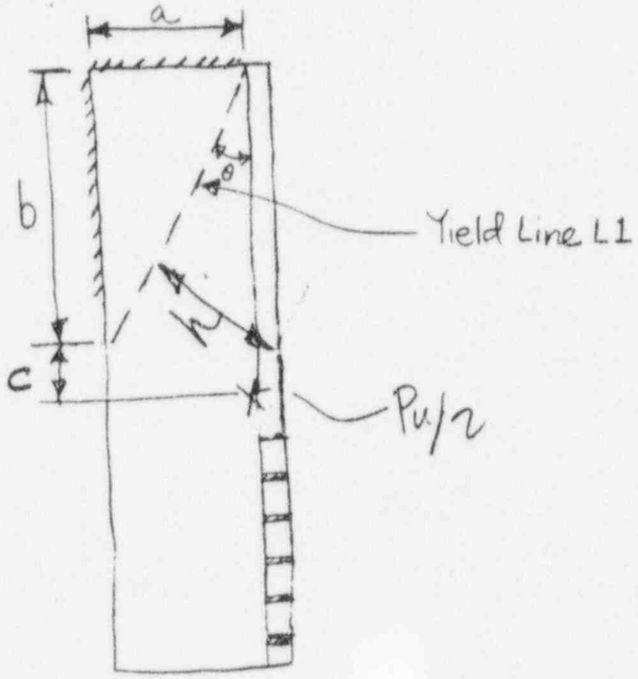
$Sy := \frac{Ag \cdot ry^2}{xb}$ $\qquad Sy = 2.67 \cdot in^3$

$AMZ_{OP\_BEND\_ANG} := SF \cdot Sy \cdot 0.95 \cdot Fy$

$AMZ_{OP\_BEND\_ANG} = 11.42 \cdot kip \cdot ft$

Outstanding Leg Bending:

The local bending capacity of the outstanding leg will be calculated based on a yield line pattern. The yield pattern for the beam axial load Rz is shown in the following sketch:



The parameters are:

$a = 3 \cdot in - 0.75 \cdot in$ $\quad b = 19.25 \cdot in$ The actual b dimension per walkdown is 24", but use of 19.25 inch is conservative.

$c = 3 \cdot in$

$t = 0.375 \cdot in$ $\quad m_p = \frac{Fy \cdot t^2}{4}$ $\quad m_p = 1.27 \cdot kip \cdot \frac{in}{in}$

$\theta = \mathrm{atan}\left(\frac{a}{b}\right)$ $\theta = 6.67 \cdot deg$

$h = (b + c) \cdot \sin(\theta)$ $h = 2.58 \cdot in$

Rotation of line L1: $\Delta = 0.0625 \cdot in$ arbitrary; cancels out

$\phi(\Delta) = \frac{\Delta}{h}$

Work Done by line L1:

$W_{L1}(\Delta) = \sqrt{a^2 + b^2} \cdot m_p \cdot (\phi(\Delta))$

Equate this to the work done by the out of plane load times Δ:

$P_u = \frac{\sqrt{a^2 + b^2} \cdot m_p}{h} \cdot 2$ $P_u = 18.99 \cdot kips$ Two is for the two clip angles.

Determine the axial load Rz allowable; first determine the effect of the the axial load Ry on the above yield line capacity. Per AWS D1.1 (Ref 5), the impact of axial stress on the yield line capacity is given by the following multiplier:

$Q_f(U) = 1.22 - 0.5 \cdot U$

Where U is the utilization factor and is defined as the ratio of axial stress to axial stress allowable. Thus:

$fa = \frac{Ry}{Ag}$

$fa = 5.44 \cdot ksi$

$Fa = 0.95 \cdot Fy$

$U = \frac{fa}{Fa}$ $U = 0.16$

Thus:

$Q_f(U) = 1.14$ >1; Thus no impact on the yield line capacity.

$ARZ_{OP\_AB\_ANG\_OLEG} = 0.95 \cdot P_u$

$ARZ_{OP\_AB\_ANG\_OLEG} = 18.04 \cdot kips$

COMMONWEALTH EDISON COMPANY

CALCULATION NO. 9389-04-D2-SW	PROJECT NO. 9389-04 (9630-66)	PAGE NO. 185.3
REVISION NO. 0		
PREPARED BY: S J Chakraborty DATE: 2/29/96	REVIEWED BY: [illegible]	DATE: [illegible]

Angle Stress Interaction Local:

$$r1 = \frac{Rz}{ARZ_{OP\_AB\_ANG\_OLEG}} \qquad r1 = 0.83$$

Angle Stress Interaction Global

$$r2 = \frac{Ry}{ARY_{OP\_BEND\_ANG}} + \frac{Rz}{ARZ_{OP\_BEND\_ANG}} + \frac{Mz}{AMZ_{OP\_BEND\_ANG}}$$

$r2 = 0.86$

$$r_{angle} = \max\left(\begin{pmatrix} r1 \\ r2 \end{pmatrix}\right) \qquad r_{angle} = 0.86$$

E19

Beam Web Cope

Capacities from Ref. 3:

$ARX_{SSE\_WEB\_COPE} = 4.174 \cdot kips$

$ARY_{SSE\_COPE\_BND} = 274.955 \cdot kips$

$ARZ_{SSE\_COPE\_COMP} = 79.628 \cdot kips$

$AMZ_{SSE\_WEB\_COPE} = 1.565 \cdot ft \cdot kips$

$rc1 = \frac{Rx}{ARX_{SSE\_WEB\_COPE}}$ $rc1 = 0.15$

$rc2 = \frac{Ry}{ARY_{SSE\_COPE\_BND}}$ $rc2 = 0.1$

$rc3 = \frac{Rz}{ARZ_{SSE\_COPE\_COMP}}$ $rc3 = 0.19$

$rc4 = \frac{Mz}{AMZ_{SSE\_WEB\_COPE}}$ $rc4 = 0.77$

The interaction performed in Ref 3 is:

$rc = rc1 + rc2 + rc3 + rc4$ $rc = 1.21$

However, the Mz allowable calculated in Ref 3 is based on angle bending. Therefore, there is no need to interact it with other cope bending/axial stresses. Mz will primarily create shear at the critical cope section. Thus the interaction for cope bending/axial should be:

$rc = rc1 + rc2 + rc3$ $rc = 0.44$

By engineering judgment, the contribution to the web bending interaction by the small Mz load at the critical section would be less than 0.5. Thus OK.

APPENDIX A

Conclusion

Connection B4L is functional.

E21

ATTACHMENT F

SER RELATED TO PIPING SYSTEM OPERABILITY CRITERIA DATED SEPTEMBER 27, 1991

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

September 27, 1991

Docket Nos. 50-237, 50-249
and 50-254, 50-265

OCT 3 RECD

Mr. Thomas J. Kovach
Nuclear Licensing Manager
Commonwealth Edison Company-Suite 300
OPUS West III
1400 OPUS Place
Downers Grove, Illinois 60515

Dear Mr. Kovach:

SUBJECT: PIPING SYSTEM OPERABILITY CRITERIA, DRESDEN/QUAD CITIES (TAC NOS. 74507, 74508, 74509, AND 74510)

By letter dated August 17, 1989, you proposed piping system operability criteria for application on Dresden and Quad Cities Stations. The operability criteria will be used to evaluate conditions within a piping system and pipe supports to ensure that the safety-related piping system will continue to operate safely in the event that the piping system is found to be outside its current licensing basis criteria as described in the Final Safety Analysis Report (FSAR) and Updated Final Safety Analysis Report (UFSAR). This criteria is intended to be used to allow for interim operations until appropriate modifications to the system can be implemented during the next refueling outage or sooner.

The staff, with technical assistance from Brookhaven National Laboratory, has completed the review of the Dresden and Quad Cities piping system operability criteria. Our Safety Evaluation is enclosed. It concludes that your proposed piping system operability criteria is acceptable for Dresden and Quad Cities.

Sincerely,

Leonard N. Olshan

Leonard N. Olshan, Project Manager
Project Directorate III/2
Division of Reactor Projects - III/IV/V
Office of Nuclear Reactor Regulation

Enclosure:
Safety Evaluation

cc/w enclosure:
See next page

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO PIPING SYSTEM OPERABILITY CRITERIA

DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3

QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2

DOCKET NOS. 50-237, 50-249, 50-254, AND 50-265

INTRODUCTION

Commonwealth Edison Company (CECo) by letter dated August 17, 1989, transmitted proposed piping system operability for application on Dresden and Quad Cities Stations. The operability criteria will be used to evaluate conditions within a piping system and pipe supports to ensure that the safety-related piping system will continue to operate safely in the event that the piping system is found to be outside its current licensing basis criteria as described in the Final Safety Analysis Report (FSAR) and Updated Final Safety Analysis Report (UFSAR). This criteria is intended to be used to allow for interim operations until appropriate modifications to the system can be implemented during the next refueling outage or sooner.

By letter dated January 11, 1991, we requested additional information. CECo provided this information in a letter dated March 22, 1991.

DISCUSSION AND EVALUATION

According to the operability criteria, piping stresses of Dresden/Quad Cities are calculated in accordance with currently licensed FSAR methods and piping codes with the exception that Regulatory Guide (R.G.) 1.61 damping values will be used. Two loading conditions are considered. The first condition correlates with normal or design conditions where the combined longitudinal pressure stress plus stresses due to sustained loads are limited to S_y, the specified minimum yield strength at temperature. The second condition correlates with faulted conditions and includes additional loadings due to safe shutdown earthquake (SSE) and Mark I torus attached piping loads. The combined stresses are limited to $2S_y$. These primary stress limits are equivalent to the current ASME Code requirements and are consistent with the limits accepted by the staff for Palisades and Ft. Calhoun Stations. Stresses due to other design loadings such as safety/relief valve steam hammer or pump trip water hammer, if applicable, will be combined with SSE in accordance with FSAR/UFSAR load combinations and the results are limited to $2S_y$. Conformance to the above stress limits provides assurance that the structural integrity and functionality of the piping system is preserved. In addition, the licensee has committed to evaluate piping secondary stresses against the existing FSAR/UFSAR allowables. The evaluation, however, will not include anchor motion due to earthquakes, because in the operability evaluation, only the low probability SSE load case (one occurrence assumed per design) is considered. Not including a one-time occurring load case in a secondary stress evaluation is consistent with current ASME philosophy. We find the above piping stress operability criteria to be acceptable for interim use.

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For pipe support operability criteria, in addition to the gravity and dynamic loadings previously specified, the evaluation includes pipe thermal loads and loads from seismic (SSE) anchor movements. We find that the pipe support criteria, in general, correlate with the Level D limits specified for components and components supports in ASME Code, Section III, Appendix F, 1986 Edition. This assures structural integrity of pipe supports and is acceptable to the staff.

With regard to the use of R.G. 1.61 damping in the operability determination, the licensee stated that the use of 2% damping for SSE which is consistent with R.G. 1.61 had been used as an initial acceptance allowable during the IE Bulletin 79-14 program. Furthermore, the record indicates that the NRC staff had suggested the use of R.G. 1.61 damping with FSAR techniques instead of the Code Case N-411 damping during the licensee interim operability evaluation of the reactor recirculation pump snubbers in 1986. The licensee also pointed out the conservatism in the SSE design response spectrum which was obtained by multiplying the corresponding OBE spectrum by two with no allowance for higher damping in the structure during an SSE. In addition, the NUREG/CR-0891 comparison between the El Centro time history response spectrum (used in the analysis of the reactor-turbine building) and the Housner design response spectrum showed additional margin in the seismic load. Based on the above, we judge the use of the R.G. 1.61 damping to be acceptable for interim operability evaluations.

In summary, the operability criteria limits proposed by the licensee are typically equivalent to ASME Code Section III, Level D limits. The operability criteria provide a simple approach for evaluating the interim acceptability of a discrepant condition when stresses and loadings exceed FSAR/UFSAR limits. It is noted that if a piping system is found to exceed FSAR/UFSAR limits, but meets the operability limits, repairs or modifications shall be made by the next refueling outage, or sooner, to return the system within FSAR/UFSAR limits.

Principal Contributor: A. Lee, EMEB

Date: September 27, 1991

Address Reply to: Post Office Box 767
Chicago, Illinois 60690

January 5, 1981

Mr. James G. Keppler, Director
Directorate of Inspection and
Enforcement - Region III
U.S. Nuclear Regulatory Commission
799 Roosevelt Road
Glen Ellyn, IL 60137

Subject: Dresden Station Units 2 and 3
Quad Cities Station Units 1 and 2
Additional Response Concerning
IE Bulletin 79-14
NRC Docket Nos. 50-237/249
and 50-254/265

Dear Mr. Keppler:

This letter is to respond to several open items which were discussed in the December 9, 1980 meeting in the NRC Offices in Bethesda, Maryland, and are identified below:

1. Presentation of revised initial acceptance allowables for combined piping system stresses during an SSE event.
2. Presentation of initial acceptance allowables for combined pipe support stresses during an SSE event.
3. Criteria for converting problems analyzed by the Blume alternate analysis criteria to computer analysis.
4. Justification for qualifiying all piping previously analyzed to the original project acceptance criteria.

Our response to each of the open items is provided in Attachment 1.

Please address any questions concerning this matter to this office.

Very truly yours,

Robert F. Janecek
Nuclear Licensing Administrator
Boiling Water Reactors

[illegible]

[illegible] - Dresden
III Inspector - Quad Cities

[illegible]

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Attachment 1

Revised Initial Acceptance Criteria for Piping Systems

The revised initial acceptance criteria are based on recent EDS Nuclear evaluations of selected systems where hand-evaluated stresses exceed the original project acceptance criteria. These refined evaluations included:

1. Comparative studies of all systems having excessive calculated stresses to determine the "worst case" systems and categorization of all systems so that one or more "worst case" systems envelop the remaining systems.

2. Refined linear analysis on the "worst case" system. The refinements have included use of Response Spectra dynamic analysis, modelling of all piping including attached non-safety related piping and usage of more appropriate damping values.

3. Nonlinear analysis of the "worst case" system in order to determine a more realistic assessment of the margin of safety than exists in the original project acceptance criteria and how that margin can be used as the basis for revised criteria.

Based on these evaluations and review of all systems in the Quad Cities Unit 1 plant, EDS has developed revised initial acceptance criteria which are consistent with the discussions held between Commonwealth Edison, EDS and the NRC on December 9, 1980.

The basic criterion that EDS intends to utilize for piping analysis is as follows:

$$\sigma_{SSE} + \sigma_g + \sigma_p < 2\sigma_y$$

for all carbon steel piping. The criteria for stainless steel differ slightly and are established as follows:

$$1.\ \sigma_{SSE} + \sigma_g < 2\sigma_y$$

As assurance that a buckling mode will not occur and hence prevent flow, and

$$2.\ \sigma_{SSE} + \sigma_g + \sigma_p < 2.2\sigma_y$$

... that structural integrity is maintained ... will not occur.

The calculation of stresses due to an SSE will be made using a damping value of 2% which is more suitable for such an event and is supported by R.G. 1.60. It is further supported by the refined linear analysis that we have performed.

The second criterion adopted for stainless steel piping is appropriate for the following reasons:

1. Yield properties for stainless steel are at least 10% greater than those listed in the code.

2. There is a far greater margin between ultimate strength and yield strength for stainless steel. This justifies the distinction between a strain limiting criterion, tied to twice yield stress and integrity criterion, tied to ultimate stress. Since the pressure stress contributes to the latter type of failure, but not the former, it should be included in the latter only.

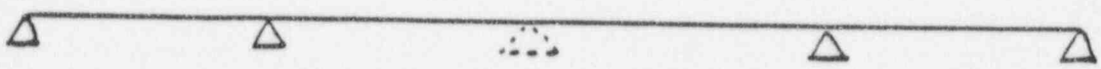
Initial Acceptance Criteria for Pipe Supports

Stress/load limits used as pipe support acceptance criteria for existing supports are attached as Appendix I. Also included for reference are criteria in effect for new designs added to satisfy FSAR criteria as part of the 79-14 effort.

Conversion of Blume Curve Analysis to Computer Analysis

The EDS criteria for conversion of Blume curve analysis to computer analysis has to this time been based solely on economic considerations. When computer analysis showed potential for a significant reduction in the number of required piping supports, it was used. On this basis, there were only two families of problems which were not converted to computer analysis:

1. Lines where two or less additional supports are required at intermediate locations:



Henceforth, these problems will be evaluated first by hand calculation and then, if necessary, by computer analysis. This approach has reduced the number of required additional supports from that indicated by the Blume curves, in some cases to none.

PIPING SYSTEM OPERABILITY CRITERIA
FOR
COMMONWEALTH EDISON'S
DRESDEN AND QUAD CITIES
NUCLEAR GENERATING STATIONS

Prepared for:

Nuclear Regulatory Commission

Prepared by:

Commonwealth Edison Company

March 1991

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NOMENCLATURE

F_a = Axial stress permitted in the absence of bending moment
F_b = Bending stress permitted in the absence of axial force
F_t = Tensile Stress
F_{to} = Allowable tensile stress in a concrete expansion anchor
F_v = Shear Stress
F_{vo} = Allowable shear stress in a concrete expansion anchor
F_w = Stress in a fillet weld
S_{cr} = Critical buckling load
S_{DBE} = Piping stress due to an SSE
S_g = Stress due to sustained loads, typically gravity
S_{MarkI} = Piping stress due to Mark I torus attached piping loads
S_p = Longitudinal pressure stress
S_u = Specified minimum tensile strength at temperature
S_y = Specified minimum yield strength at temperature

TABLE OF CONTENTS

1.0 INTRODUCTION

The purpose of this licensing submittal is to present an operability criteria for piping systems at Dresden and Quad Cities nuclear stations. These criteria will be used to evaluate discrepant conditions within piping systems and pipe supports which may cause the piping or support to exceed design limits. While the discrepant conditions usually do not cause piping or supports to exceed design limits, system operability is in question and must be evaluated if design limits are exceeded. The criteria defined herein provide stress limits for piping and supports which ensure the piping system can perform the intended design function (i.e. maintain pressure boundary and deliver required flow).

Based upon experience obtained while operating six nuclear plants and upon consideration of the industry experience, Commonwealth Edison Company (CECo) is preparing a procedure for handling piping and pipe support discrepancies found in the plant. This licensing submittal proposes criteria which will be used in the above mentioned procedure to assure safety-related piping systems will continue to operate safely during the interim period that a discrepant condition exists. The proposed criteria are intended to supplement those currently described and approved in the FSAR, UFSAR, and Technical Specifications for Dresden and Quad Cities nuclear stations. R

The operability criteria presented herein assure safe operation of the piping system even if the stresses and loadings in the piping system exceed FSAR limits. Discrepancies between the design documentation and the as-built configuration are considered as unanalyzed conditions. Examples are:

- o Missing or inoperable supports
- o Broken welds or supports
- o Discovery of an error in the design documentation
- o Snubber failures

Current requirements force systems to be placed into a limited condition of operation (LCO) when unanalyzed conditions cause the piping to exceed FSAR limits. Piping systems placed in a LCO often require modifications before returning to operation. CECo will not invoke a LCO if the operability criteria presented herein are met. Implementation of the operability criteria would allow engineering the additional time to evaluate the best engineering solution to solve the root cause of the discrepancies and prevent reoccurrence.

CECo proposes to use the operability criteria to permit interim operation only. Repairs and/or modifications will be made to return a system within FSAR limits by the next refueling outage, or sooner if operation permits, unless specific approval is obtained by the NRC for continued operation. The operability criteria are not intended to avoid appropriate actions.

2.0 SCOPE

This document applies to safety-related piping systems installed at CECo's Dresden and Quad Cities nuclear stations. The operability criteria shall apply when an unanalyzed condition causes a piping system to exceed the current design basis criteria in the plant's FSAR and UFSAR.

Sections 3 and 4 detail the proposed criteria for piping and pipe supports, respectively. The analysis methods proposed for operability evaluations shall be limited to those described and approved in the current FSAR and UFSAR, unless specifically noted herein or unless alternate methods are approved by the NRC.

Included as an appendix are discussions of operability criteria used at other nuclear facilities. The criteria proposed in this document are consistent with those currently approved for use at other facilities.

3.0 PIPING OPERABILITY CRITERIA

3.1 Piping Stress Criteria

The piping stresses shall be calculated in accordance with the piping codes and FSAR methods currently licensed for each station with the exception that Regulatory Guide 1.61 (Reference 4) damping values shall be used. The proposed operability criteria limits for primary piping stresses (including the effects of integral attachments) are given below. Piping secondary stresses shall be evaluated against the existing FSAR/UFSAR allowables:

$$S_g + S_p < S_y \quad (1)$$
$$S_g + S_p + SRSS\ (S_{DBE},\ S_{SAM}) < 2\ S_y \quad (2)$$

Equation (1) correlates with normal or design conditions and Equation (2) correlates with faulted conditions.

Stresses due to other design loadings such as SRV steam hammer or pump trip water hammer, if applicable, shall be combined with SSE in accordance with FSAR/UFSAR load combinations and the results shall be less than $2S_y$.

3.2 Other Considerations

3.2.1 Flanges

Flanges shall meet standard requirements of the piping codes referenced in the FSAR/UFSAR with the exception that OBE will not be included.

3.2.2 Piping Deflections

Piping deflections calculated by the analysis of the discrepant condition will be evaluated using the current criteria for each plant.

For instances where the calculated deflections exceed these criteria, walkdowns shall be performed to determine if there is a potential for interactions with other plant items. If no potential interactions are found, this piping operability criteria may be used. However, if interactions need to be evaluated, the evaluation of these interactions and the determination of piping operability is beyond to scope of these piping operability criteria.

4.0 PIPE SUPPORT OPERABILITY CRITERIA

In addition to the gravity and dynamic loadings in Section 3, the support loads shall include pipe thermal loads and loads from seismic (SSE) anchor movements.

Should the support stresses not meet their operability limits, then additional iterative analyses of the piping may be required. The iterative analyses may use the knowledge that a support is not capable of withstanding the loads, and can be removed from the analysis. Where feasible, the actual support stiffness may be included in the iterative analyses.

4.1 Standard Pipe Supports

Standard pipe supports are those support components available in vendor catalogs. The operability criteria for these components will be based on Section 4.1.1 or Section 4.2.

4.1.1 Operability Criteria Using Manufacturer Allowables

The maximum calculated load in a standard support (excluding snubbers) obtained from the analysis of the unanalyzed condition shall not exceed the greater of the following:

a) Manufacturer ultimate tested load divided by a factor of safety of 2, except that a factor of safety of 3 will be used for U-bolts (Reference 5).
b) Manufacturer allowable for Service Level D.
c) Manufacturer allowable for Service Level A multiplied the lesser of a factor of 2 or $1.167\ S_u/S_y$, if $S_u > 1.2S_y$ or a factor of 1.4 if $S_u \leq 1.2S_y$ (Reference 6).

If manufacturer allowables are not available, the criteria for linear type supports detailed in Section 4.2 shall be used.

4.2 Linear Type Supports

4.2.1 Structural Steel

The maximum calculated stress obtained from the analysis of the unanalyzed condition shall not exceed the operability criteria listed below:

Tension, Bending	$F_t, F_b = 1.2S_y$ but $< .7S_u$
Shear	$F_v = \text{Min}(.42\ S_u,\ .72S_y)$
Compression	$F_a = \text{Min}\ (F_t,\ .67\ S_{cr})$
Combined Stress	Axial tension (or compression) combined with bending using Reference 2
Web Crippling	$= 1.0\ S_y$
Fillet Welds	$F_w = .42\ S_u$ (of weld material)

Stress limits will be based on code values for S_y and S_u.

4.2.2 Structural Bolts

The maximum calculated tensile load in a structural bolt shall not exceed the lesser of $1.0S_y$ and $0.7S_u$. The maximum calculated shear stress shall not exceed the lesser of $.42S_u$ and $.6S_y$ (Reference 2).

4.2.3 Concrete Expansion Anchors

The operability limits for loads in tension and shear acting on concrete expansion anchors shall be obtained from the manufacturer's reported ultimate capacities with a factor of safety of 2.

Anchors subjected to combined tension and shear shall be evaluated using linear interaction.

$F_t/F_{to} + F_v/F_{vo} \leq 1.0$

4.3 Other Considerations for Pipe Supports

4.3.1 Spring Hangers

Spring hangers shall be evaluated to accommodate the maximum pipe movement without bottoming out.

4.3.2 Snubbers

The maximum calculated load taken by a snubber obtained from the analysis of the unanalyzed condition shall not exceed the Level D allowable published by the vendor. For example, PSA mechanical snubbers define faulted allowables as 1.55 times the normal rated load.

Snubbers shall also be reviewed to ensure they can accommodate thermal movements without exceeding travel limits.

4.3.3 Containment Penetrations

The portions of the penetration boundaries governed by piping design requirements shall meet the criteria detailed in Section 3 of this document.

The remaining portions must meet the limits given in ASME Section III, Subsection NE (Reference 3) for faulted conditions.

5.0 Summary

The piping operability criteria presented will assure safe operation of a piping system even if stresses and loadings exceed FSAR/UFSAR limits. If a piping system is found to exceed FSAR/UFSAR limits, but meets the operability limits, repairs and/or modifications will be made by the next refueling outage, or sooner to return the system within FSAR/UFSAR limits.

As detailed in Appendix A, the proposed piping operability criteria are consistent with criteria licensed at other nuclear facilities. The operability criteria limits proposed herein are typically equivalent to ASME Section III Level D limits. The operability criteria provide a simple approach for evaluating the interim acceptability of a discrepant condition.

6.0 REFERENCES

1. Transactions of the ASME, "Fatigue Tests of Piping Components", by A.R.C. Markl, April, 1952.

2. ASME Boiler and Pressure Vessel Code, Section III, Appendix F, 1986 Edition.

3. ASME Boiler and Pressure Vessel Code, Section III, Subsection NE, 1980 Edition.

4. US AEC Regulatory Guide 1.61, "Damping Values for Seismic Design of Nuclear Power Plants", October, 1973.

5. IE Bulletin No. 79-02, Revision No. 1, (Supplement No. 1), dated August 20, 1979.

6. Regulatory Guide 1.124, "Service Limits and Loading Combinations for Class 1 Linear-Type Component Supports," Revision 1, January 1978.

Appendix A

PRECEDENT FOR OPERABILITY CRITERIA

1. Generic Criteria for Justification of Continued Operation (JCO) Northern States Power, Prairie Island Nuclear Generating Plant (Reference A1).

   This document details a criteria for JCO when encountering major discrepancies in as-built safety related piping. This criteria was licensed for use at the Prairie Island Nuclear Station. The proposed criteria for CECo's nuclear stations is essentially the same, determining piping operability on the basis of limiting pipe stresses to ASME Section III Level D limits.

2. Modification Priorities for Pipe Supports on Rigorously Analyzed Piping - Sequoyah Units 1 and 2, TVA (Reference A2)

   The criteria detailed in this document provides justification for continued operation of piping systems which require modifications to meet FSAR limits. This criteria allows the modifications to be delayed for an interim period. Once again, these criteria are essentially the same as those proposed in this document.

3. IEB 79-02 Supplement 1, "Pipe Support Base Plate Designs Using Concrete Expansion Anchor Bolts" (Reference A3)

   The bulletin allows interim operation of a piping system even though the installed piping system does not meet design allowables (i.e. using design factors of safety) for pipe supports. The recommended factors of safety for interim operation are adopted in this document. The linear interaction relation for combining shear/tension proposed in this document is conservative compared to those proposed in Reference A9.

4. Responses to NRC IE Bulletin 79-14 at Pilgrim Nuclear Power Station (Reference A4)

   This document contains system operability criteria for addressing discrepancies found while the plant was operating. For piping and pipe supports which exceeded the operability criteria, Boston Edison implemented design modifications immediately. In some cases, the modifications were temporary and were made to restore the piping and supports to be within operability limits but not code limits.

   The criteria limited piping stresses to ASME, Class 2/3 Level D allowables and support loads to values equivalent to those proposed in this document.

5. Proposed Short Term Functionality Criteria for Songs-1 Piping Systems (Reference A5)

As part of the long term seismic upgrade program performed at San Onofre, short-term operability and functionality criteria were developed. The criteria was intended to be suitable for an interim operation period until the plant could be modified to meet the NRC design requirements for a 2/3 g level earthquake.

The criteria limit for piping of $2S_y$ was based upon non-linear analyses to show that piping systems are maintained at conditions well within the bounds of that required for safe shutdown when elastic analyses identify stresses of $2S_y$. The criteria for pipe supports follow the recommendations of Regulatory Guide 1.124 and SRP 3.9.3 and are essentially the same as those proposed in this document.

6. IE Bulletin 79-14 Criteria for Piping Analysis Initial Acceptance Criteria, Dresden and Quad Cities (References A6, A7 and A8)

During the IEB 79-14 work at Dresden and Quad Cities, special analysis criteria were used when FSAR limits were exceeded. These criteria were established to ensure the system could function during and immediately after a safe shutdown earthquake.

The initial acceptance criteria for pipe stresses were identical to that proposed in this document. The criteria were licensed for use and are included in the UFSAR for each plant.

REFERENCES

A.1 Letter from David Musolf, NSP to the NRC "Generic Criteria for Justification of Continued Operation", Prairie Island Nuclear Generating Plant, Docket Nos. 50-282, 50-306, dated September 26, 1988.

A.2 Letter from R.L. Gridley/TVA to the NRC, "Sequoyah Nuclear Plant (SQN) - Unit 2 - Pipe Support Modification Restart Criteria Meeting Summary", Docket Nos. 50-327, 50-328, October 6, 1987.

A.3 IE Bulletin 79-02, Supplement 1, Revision 1 "Pipe Support Base Plate Designs Using Concrete Expansion Anchor Bolts", August 20, 1979.

A.4 Letter from Boston Edison Company to the NRC "NRC IE Bulletin 79-02 and IE Bulletin 79-14, Final Report", Docket No. 50-293 July 19, 1982.

A.5 NRC's Safety Evaluation Report, "Safety Evaluation by the Office of Nuclear Reactor Relating to the Long-Term Service Seismic Reevaluation Program, Southern California Edison Company, San Diego Gas and Electric Company, San Onofre Nuclear Generating Station, Unit No. 1, Docket No. 50-206, "provided by NRC letter to Kenneth P. Baskin (SCE) from Thomas M. Novak (NRR), dated July 11, 1986.

A.6 Quad Cities UFSAR, Volume 3, Section 12.

A.7 Dresden UFSAR, Volume 3, Section 12.

A.8 Letter from R.F. Janecek to the NRC, "Dresden Station Units 2 and 3, Quad Cities Station Units 1 and 2, Additional Responses Concerning IE Bulletin 79-14", Docket Nos. 50-237/249 and 50-254/265, January 5, 1981.

A.9 Electric Power Research Institute Report No. NP-5228, "Seismic Verification of Nuclear Plant Equipment Anchorage", May 1987.