PIPING SYSTEM OPERABILITY CRITERIA

FOR

COMMONWEALTH EDISON'S

DRESDEN AND QUAD CITIES

NUCLEAR GENERATING STATIONS

Prepared for:

Nuclear Regulatory Commission

Prepared by:

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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_{OBE}	=	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:

- Missing or inoperable supports
- Broken welds or supports
- Discovery of an error in the design documentation
- 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. R

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: R

$$S_g + S_p < S_y \quad (1)$$

$$S_g + S_p + \text{SRSS}\ (S_{DBE},\ S_{Mark\ I}) < 2\ S_y \quad (2)$$

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 $2S_y$. R

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. R

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. R

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. R

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). R
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). R

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. R

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. R

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.

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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.