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Rev. 2

INDEPENDENT DESIGN REVIEW

PIPE SUPPORT DESIGN REVIEW CRITERIA

FOR

COMANCHE PEAK NUCLEAR PLANT - UNIT 1

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1.0 INTRODUCTION

This document establishes general technical criteria to be used in the review of pipe supports, shock suppressors, and anchors associated with the Residual Heat Removal/Safety Injection system piping scope described below. The purpose of this review is to ensure that the pipe supports are capable of supporting the piping system during all conditions of operation by transmitting the loads from the pipe to the building structural members. This document shall be used in conjunction with Work Instruction 1, "Assessment Procedures," for guidelines on the review methodology and documentation requirements.

2.0 SCOPE

This criteria document shall be used in the review of pipe supports and shock suppressors located along the main flow path of the Residual Heat Removal/Safety Injection System - Train B taken from the heat exchanger (Tag No. TBX-RHAHPS-02) to the containment penetration MS-2. In addition, anchors located on the branch lines which define the stress analysis problem bounds shall be reviewed in accordance with this document.

3.0 CODES, STANDARDS AND REFERENCE DOCUMENTS

Based on industry standards and codes in effect at the time of the original design, as well as documents which form part of the licensing basis for Comanche Peak, the following list of reference documents shall be used for the review:

- ASME Boiler and Pressure Vessel Code Section III, Subsection NF, 1974 Edition with Addenda through and including Winter of 1974.

- American Institute of Steel Construction, Inc., AISC Steel Construction Manual, 7th edition.

- American Welding Society, Structural Welding Code, AWS D.1.1., 1979.

- Gibbs & Hill, Inc., Specification No. 2323-SS-30, Appendix 2.

- Gibbs & Hill, Inc., Specification No. 2323-MS-200, Revision 3.

- Gibbs & Hill, Inc., Specification No. 2323-MS-46A, Revision 3.

- Texas Utilities Services, Inc. Procedure CP-E1-4.5-1, Rev. 9.

- Brown & Root, Inc. Procedure No. CP-CPM-9.10, Rev. 11.

4.0 DESIGN

4.1 Physical Requirements

4.1.1 Stiffness

When actual stiffness is not available, the estimated stiffness of a pipe support in the pipe's restrained direction must meet the required stiffness shown in Exhibit 4.1-1 according to the nominal size of the restrained pipe. The minimum stiffness requirement may be waived when the actual computed stiffness is used. The final stiffness of the pipe support shall be based on the as-built configuration and properties of the support. Stiffness of the pipe support in the unrestrained direction shall have sufficient rigidity to provide a stable structure based on good engineering practice. The stiffness calculation shall consider the combined effects of the support frame and mechanical components. The flexibility of the building structure need not be included in the stiffness calculation.

4.1.2 Gaps

A gap shall be provided to accommodate radial expansion and construction tolerances. The maximum total gap allowed in the restrained direction is 1/8" (± 1/16" installation tolerance). In unrestrained directions, the support design shall allow clearance for the most severe thermal plus seismic movements of the pipe. Proper installation tolerances shall be provided where thermal movement cannot be accommodated within the specified gap minus 1/16".

4.1.3 Deviations

The design location of the supports should be within the tolerances of TUSI Verification Procedure CP-EI-4.5-1, i.e., ± 2".

4.1.4 Spring Supports

Spring supports shall be capable of exerting a supporting force equal to the load, as determined by weight-balance calculations, plus the weight of all hanger parts, such as clamps and rods, that will be supported by the spring. The design shall be such as to prevent complete release of the component load in the event of spring failure or misalignment. Any variability of a supporting spring force resulting from movement of the component shall be considered in the loadings used in the stress analysis of the component. The spring's available travel will be checked against all the thermal and seismic movements. Spring support shall also be designed for a maximum variation in supporting effort of 20 percent for a total travel resulting from thermal movement of the pipe.

4.1.5 Rod Hanger

Rod hangers shall be subjected to tensile loading only if specific gapping instructions are indicated on the drawings. Rod hanger assemblies shall be designed to allow anticipated thermal horizontal movement without subjecting the pipe to extraneous loads. The maximum swing angle due to horizontal pipe movement should be less than 5°. If the swing angle of the rod is in excess of 5° the hanger shall

be offset two-thirds of the thermal movement towards the direction of movement. Rod hangers for piping more than 2-1/2 inches should not be less than 1/2 inch diameter.

4.1.6 Snubbers

The snubber assembly shall be offset two-thirds of the thermal movement in the cold position if the swing angle exceeds 5°. The midpoint of thermal travel for snubber strokes should be set at the midpoint of the total travel with hot and cold settings established accordingly. In situations where space limitations prohibit this, snubbers shall be set with at least a 1/4" margin provided within the snubber stroke after worst case thermal conditions are considered. The maximum travel range of the snubber must be checked under maximum thermal movements.

4.1.7 Sway Struts

Sway Struts are used to restrain movement of piping in one direction while providing for thermal movement in the unrestrained direction. Functionally, the rigid sway struts are similar to snubbers except that the sway strut does not allow free thermal movement in the restrained direction. In other words, the sway strut takes up static and dynamic loading. The maximum swing angle due to misalignment or thermal movement should be less than 5°.

4.1.8 Base Plates and Anchor Bolts

Base plate stiffness and prying effect shall be considered in the design review of the pipe supports. The Teledyne

method, a finite element analysis, or any rational analysis may be used to check the adequacy of the base plate and anchor bolts.

4.1.9 Structural details shall conform to the requirements of the AISC Manual of Steel Construction.

4.1.10 All seismic supports shall be plus and minus restraints. Regardless of other imposed loads, the pipe must be physically restrained in each direction along the restraining axis. The exception to this is the case of a vertical support for which the dead weight and dead weight plus thermal loads allow use of a uni-directional restraint.

4.1.11 The support calculations shall reflect the actual support geometry and load distribution. Changes to the initial geometry, or use of one geometry to qualify a different geometry, shall be justified.

4.2 Restraint Loads

The loadings that shall be taken into account in designing a component support include, but are not limited to, the following:

- Weight of the component, insulation, and normal contents (DL). Pipe and component weights from manufacturer's data.

- Loads generated by restrained thermal expansion. These include temperatures at normal operating conditions (TH).

- Friction loads (FL) are to be applied in the direction of thermal movement. The magnitude of this load shall be the friction coefficient times the larger of a) the algebraic sum of the pipe's dead load and the maximum thermal load or b) the pipe's dead load. The friction coefficient for steel on steel shall be 0.3 and for steel on teflon 0.07.

- Safe Shutdown Earthquake, Inertia and anchor movement loads included (SSE).

- Pipe Impact Loads (PI)

- Jet Impingement Loads (JI)

4.3 Loading Combinations

The following loading conditions should be used for the design review of pipe supports:

1)	Testing condition	DL
2)	Design and normal operating condition	DL + TH + FL
3)	Upset operating condition	DL + TH + 1/2 (SSE)
4)	Emergency operating condition	DL + TH + SSE + PI + JI
5)	Faulted operating condition	DL + TH + SSE + PI + JI

4.4 Allowable Stress

Allowable stresses should follow the ASME Boiler and Pressure Vessel Code Section III, Subsection NF, and the appropriate sections of American Institute of AISC Specifications, and structural steel members should meet all the AISC requirements.

Exhibit 4.4.1 contains a table of allowable stresses to be used in the review for A36 steel, A307 bolt and E70S weld at room temperature.

4.5 Anchor Bolt Design

4.5.1 Applications

a. deleted.

b. Anchors must be at least 1/2" diameter when used for structural connections or for anchorage of pipes greater than 2" diameter.

c. Embedded length of anchor shall be exclusive of thickness of grout pad or other overlay.

4.5.2 Allowable Loads

a. Allowable loads shown in Exhibit 4.5-1, shall apply to anchors installed in ordinary concrete with f'_c = 4000 psi only.

b. For concrete strength between 3 ksi and 5 ksi, the data in Exhibit 4.5-1 may be ratioed up or down.

c. Allowable load values given in this standard shall not be increased because of short duration of loading (e.g., for wind or seismic loads).

d. If center-to-center spacing of anchors is less than 10 diameters and/or if distance from edges of concrete to center of anchor is less than 5 diameters, the allowable loads shall be reduced in accordance with the Gibbs & Hill Project Design Specification 2323-SS-30, Appendix 2.

e. For anchors which will be subjected simultaneously to pullout and shear forces, the allowable load values used must satisfy the following formula:

$$\left(\frac{P_C}{P_D}\right) + \left(\frac{S_C}{S_D}\right) \leq 1$$

where:

P_D, S_D = allowable loads (pullout, shear), reduced for spacing or edge distance if appropriate.

P_C, S_C = design loads to be used in cases where pullout and shear loads may occur simultaneously.

5.0 EXHIBITS

Exhibit 4.1-1 Stiffness of Piping Supports

Exhibit 4.4-1 Allowable Stresses

Exhibit 4.5-1 Allowable Load on Expansion Anchors

EXHIBIT 4.1-1

SPRING CONSTANTS (STIFFNESS) OF PIPING SUPPORTS
(Application for Seismic and Thermal Analyses)

1) Rigid Restraints

Nominal Pipe Size (in.)	Translational Stiffness Kt (lb./in.)	Rotational Stiffness Kr (in.-lb./rad.)
Under 6	2×10^5	1×10^7
6 to 14	1×10^6	1×10^8
Over 14	5×10^6	1×10^9

2) Mechanical Shock Arrestor

Nominal Pipe Size (in.)	Rated Load (lbs.)	Stiffness K (lbs./in.)
Under 2	1,000	1×10^5
2 to 6	3,000	2×10^5
8, 10, 12	10,000	3×10^5
Over 12	35,000	1.35×10^6

Note: Stiffnesses shown here are obtained from the reference document, Gibbs & Hill, Inc. Specification No. 2323-MS-200, Revision 3, Table 3.4-1.

EXHIBIT 4.4-1

ALLOWABLE STRESSES

	Load Case			
	Testing, Normal & Upset			
Stress	Value	KSI	Emergency	Faulted
Tension	0.6 F_y	21.6		
Shear	0.4 F_y	14.4		
Web Crippling	0.75 F_y F_a per AMSE Appendix XVII-2213	27.0		
Bending	As per ASME Appendix XVII-2214		1.33 x Normal Allowable	As per ASME Code, Section III, App. F
Bearing	0.9 F_y	32.4		
Bolts Tension & Shear	Allowable Tension per ASME Appendix XVII-2460			
Welds (Fillet, Full or Partial Penetration):	Per ASME III,NF Table NF-3292.1-1			
Anchor Bolts	(See Exhibit 4.5-1)			
Combined Stress	Per ASME Appendix XVII-2215			
Catalog Items	Catalog Values		1.33 x Catalog Values	As per ASME Code, Section III, App. F

Note: Allowable stresses are for designs based on room temperature.

EXHIBIT 4.5-1

ALLOWABLE LOAD ON EXPANSION ANCHORS

KWIK-BOLT

DESIGN ALLOWABLE TENSILE & SHEAR LOADS* (lbs.)

Factor of Safety		FS = 4.0		*FS = 5.0	
Diameter	Embedment	Tension	Shear	Tension	Shear
1/4"	1-1/2"	364	653	291	522
	1-1/2"	556	653	445	522
	1-3/4"	675	653	540	522
	2"	781	653	625	522
	2-1/4"	827	653	662	522
	2-1/2"	837	653	670	522
3/8"	1-5/8"	588	1276	471	1021
	2"	756	1276	605	1021
	2-1/2"	975	1276	780	1021
	3"	1075	1354	860	1083
	3-1/2"	1150	1354	920	1083
	4"	1187	1354	950	1083
	4-1/2"	1200	1354	960	1083
1/2"	2-1/4"	1377	2079	1102	1663
	2-3/4"	1800	2079	1440	1663
	3-1/2"	2362	2079	1890	1663
	4-1/2"	2806	2558	2245	2046
	5-1/2"	3012	2558	2410	2046
	6"	3075	2558	2460	2046
5/8"	2-3/4"	1650	2880	1320	2312
	3-1/2"	2275	2890	1820	2312
	4-1/2"	3000	2890	2400	2312
	5-1/2"	3575	,359	2860	3087
	6-1/2"	4000	3859	3200	3087
	7-1/2"	4250	3859	3400	3087

* Anchor bolt allowables are based on a factor of safety equal to 5 and f'_c equal to 4000 psi in the review.

EXHIBIT 4.5-1
(continued)
ALLOWABLE LOAD ON EXPANSION ANCHORS
KWIK-BOLT
DESIGN ALLOWABLE TENSILE & SHEAR LOADS* (lbs.)

Factor of Safety		FS = 4.0		*FS = 5.0	
Diameter	Embedment	Tension	Shear	Tension	Shear
3/4"	3-1/4"	2537	4283	2030	3426
	4"	3350	4283	2680	3426
	5"	4125	4283	3300	3426
	6"	4500	4616	3600	3693
	7"	5250	4616	4200	3693
	8"	5750	4616	4600	3693
	9"	5875	4616	4700	3693
1"	4-1/2"	4000	6719	3200	5375
	5"	4725	6719	3780	5375
	6"	5860	6719	4688	5375
	7"	5860	6719	4688	5375
	8"	5860	8622	4688	6898
	9"	5860	8622	4688	6898
	10"	5860	8622	4688	6898
1-1/4"	5-1/2"	5750	8920	4600	7136
	6-1/2"	6775	8920	5420	7136
	7-1/2"	7775	8920	6220	7136
	8-1/2"	8650	8920	6920	7136
	9-1/2"	9450	8920	7560	7136
	10-1/2"	10225	8920	8180	7136
1/2"	3-1/4"	2496	2860	1997	2280
	4-1/4"	3695	2860	2956	2280
	5-1/4"	3641	2860	2913	2280
	6-1/4"	3786	2860	3029	2280
1"	6-1/2"	8741	6884	6993	5507
	8-1/2"	12452	6884	9962	5507
	10-1/2"	12439	6884	9951	5507

* Anchor bolt allowables are based on a factor of safety equal to 5 and f'_c equal to 4000 psi in the review.

EXHIBIT 4.5-1
(continued)
SUPER KWIK-BOLT
DESIGN ALLOWABLE TENSILE & SHEAR LOADS* (lbs.)

Factor of Safety		FS = 4.0		*FS = 5.0	
Diameter	Embedment	Tension	Shear	Tension	Shear
1-1/4"	8-1/8"	10675	10369	8540	8295
	10-5/8"	13420	10369	10736	8295
	13-1/8"	16230	10369	12984	8295

* Anchor bolt allowables are based on a factor of safety equal to 5 and f'_c equal to 4000 psi in the review.

Note: Please refer to reference documents, Gibbs & Hill, Inc., Specification No. 2323-SS-30, Appendix 2, Pages 3 and 4, for these anchor bolt allowable loads.