IMPELL CORPORATION

PROJECT INSTRUCTION

TITLE: STRUCTURAL STEEL MEMBER EVALUATION

INSTRUCTION NUMBER: 01

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CLIENT: SOUTHERN CALIFORNIA EDISON

PROJECT: SONGS-1

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1.0 OBJECTIVE

The objective of this project is to evaluate the "as-installed" structural steel members which support large bore piping systems included in the Long Term Service (LTS) scope. Based on this evaluation, a list summarizing the qualification status for all such steel members will be prepared. Steel members which do not qualify under the LTS criteria will be identified as requiring modification. △4

2.0 SCOPE OF WORK

The purpose of this project is to determine if the "as-installed" structural steel members are adequate to support the loads imposed by large bore piping systems included in the SONGS-1 LTS scope.

The basic procedure for steel member evaluation is:

a) identify the piping supported by the member,

b) evaluate the member and it's connections for the imposed piping loads in combination with the loads due to the inertial response of the structure, and

c) evaluate the rigidity of the member for subsequent pipe/structure interaction evaluation.

Seismic piping loads (inertia and SAM) obtained as a result of the piping analyses will be for a 0.67g Modified Housner Earthquake (MHE).

The basic LTS acceptance criteria for qualifying structural steel members and their connections are defined in Section 3.8.4.5 of Reference 1. In addition, certain supplemental criteria apply to this scope of work. The table below identifies the Section(s) of this Project Instruction where the criteria are defined.

Member Type	Basic Criteria	Supplemental Criteria
Beam/Girder	Ref. 1	Section 6.1
Columns	Ref. 1	Section 6.3
Bracing Members	Ref. 1	Section 6.4
Connections	Ref. 1	Section 7.0

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Those structural steel beams which are identified to be inelastic by conservative approaches may be reevaluated using the approach outlined in Attachment A to qualify them to elastic criteria. 4

3.0 EVALUATION INPUT

The following documents are necessary design input for this scope of work:

1. Piping system LTS support loads - These loads will be generated by Impell for the piping systems included in the LTS scope. Safety-related large bore piping systems within the LTS scope of work are defined in Impell letters numbered B/P 31-128 (dated Jan. 22, 1985), B/P 31-143 (March 19, 1985), and B/P 31-182 (June 21, 1985).

   For large bore (i.e., diameter greater than 2 inches) safety-related piping systems supported by the member but not within the LTS scope, Bechtel or Impell loads generated for Return to Service (RTS), or estimated loads based on a walkdown, will be used.

2. "As-Designed" steel member calculations - These calculations were generated by Bechtel and consist of evaluations and modifications for the structural steel configuration from Return to Service (RTS).

3. "As-Installed" Civil/Structural drawings - These drawings will be used to obtain member location, dimensions, size and connection details.

4. Field walkdown data - Walkdowns will be performed per Reference 7 when information is not available from existing documentation. 4

4.0 DESIGN LOADS AND LOAD COMBINATIONS

4.1 Dead Loads (D)

In the determination of dead loads, the actual as-built data will be used where practical and appropriate. Otherwise, a uniform load will be estimated for the given area based on existing documentation or a walkdown.

4.2 Live Loads (L)

Minimum live loads shall be based upon actual loadings, or alternatively (in accordance with Section 2.7.1A of Reference 3) from ANSI A58.1 or Uniform Building Code. When evaluating the overall behavior of the structure or significant portions thereof, live occupancy loads generally need not be considered because of the light occupancy of power plants.

4.3 Loading Combinations

For structural evaluation of the steel members, only the occurrence of a MHE (defined by the 0.67g Modified Housner Response Spectrum) combined with the normal plant operating loads shall be considered. The specific loading combination to be used for this design effort, from those given in Reference 3, is as follows:

$$R = D + L + T_o + R_o + E'$$

where

R = Total resultant applied load or force

E' = Loads generated by the MHE

$$E' = (E'^2 \text{ member} + \sum^{N} E'^2 \text{ pipe})^{1/2}$$

N = number of pipe supports on the member

Note that the grouping method, as described in Reference 4, will be used to combine the dynamic responses from different piping systems. If the significant frequencies are closely-spaced, absolute summation will be used to combine piping responses.

$$E' \text{ pipe} = ((\text{MHE Inertia})^2 + (\text{MHE SAM})^2)^{1/2}$$

= The loads in the member from pipe reactions due to the 0.67 MHE.

This component of the load will be calculated as shown above for all lines being analyzed and lines greater than or equal to 8 inches in diameter. The seismic reactions due to remaining lines will be considered on a case-by-case basis, either as a distributed load or as a concentrated load on the member, depending upon the size of the line, size of the member, magnitude of the reaction and the support location. The basis for SRSS of seismic inertia and SAM loads is provided in Reference 5. 4

SAM = Seismic Anchor Movement

E' member = Loads in the member due to MHE, other than pipe reactions (i.e., the inertial response of the structure)

D = Dead loads or their related internal moments and forces

L = Applicable live loads or their related internal moments and forces

T_0 = Thermal effects and loads during normal operating conditions based on the steady-state condition

R_0 = Maximum pipe and equipment reactions during normal operating conditions based on the steady-state condition, if not included in the above loads

Notes [(a) and (b) per Table 3.8-1 of Ref. 1]:

(a) For the load combinations where D or L reduce the effects of other loads, the corresponding coefficients shall be taken as 0.90 for D and zero for L.

(b) T_0 will not be considered when it can be shown that the load is secondary and self-limiting in nature.

(c) If more than two pipe supports from the same pipe are located on a single structural member, the member stresses from these pipe reactions will be absolute-summed prior to combining this result, by the grouping method [4], with the member stresses from all other pipe reactions on the same member.

For steel beams supporting smaller steel members,

(a) the static portion of the reactions (i.e., due to D + L + To + Ro) of the smaller members attached directly to steel beams, and

(b) the dynamic portion of the reactions (i.e., due to E') of directly attached steel members

will be combined with the static and dynamic loadings, respectively, imposed on the steel beams.

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6.0 ACCEPTANCE CRITERIA FOR MEMBERS

The acceptance criteria for structural steel members evaluated in accordance with the procedure described in Section 5.0 are defined in the following subsections.

6.1 Beams/Girders

Beams or girders shall be considered elastic, and acceptable with no further evaluation required, if $1.6S \geq R$ (S and R defined in Section 7.0), e.g.:

$$\frac{fa}{Fa} + \frac{fbx}{Fbx} + \frac{fby}{Fby} \leq 1.6$$

where

fa, fbx, fby = axial, major axis bending, and minor axis bending allowable stresses, respectively, in the member due to the total resultant applied loads as defined in Section 4.3.2 above, and

Fa, Fbx, Fby = axial, major axis bending, and minor axis bending allowable stresses, respectively, based on elastic design methods and allowables defined in Part 1 of the AISC Specification contained in Reference 6.

6.2 Inelastic Member Ductility

Deleted

6.3 Columns

The criteria for structural columns will be the AISC Specification, 8th Edition, Part 2 (Reference 6). The Code provisions are for major axis bending only.

When considering major and minor axes bending moments and the axial load to determine the ultimate capacity of the steel columns, the interaction equation as specified in Reference 2 will be used. This equation is:

$$\frac{P}{Py} + \frac{1}{1.18}\frac{Mx}{Mpx} + \frac{1}{1.67}\frac{My}{Mpy} \leq 1.0$$

where

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P = Applied axial load [kips]

$P_y = F_y \times A$ = Yield stress x section area [kips]

M_x = Applied moment, major axis [kip-inches]

M_y = Applied moment, minor axis [kip-inches]

$M_{px} = Z_x \times F_y$ = Plastic moment capacity, major axis [kip-inches]

$M_{py} = Z_y \times F_y$ = Plastic moment capacity, minor axis [kip-inches]

6.4 Bracing Members

All main structural bracing members will satisfy plastic design requirements as outlined in Part 2 of Reference 6.

7.0 ACCEPTANCE CRITERIA FOR CONNECTIONS

The acceptance criteria for structural steel member connections is

$$1.6S \geq R$$

where

S = The required section strength based on elastic design methods and the allowable stresses defined in Part 1 of Reference 6, and

R = Total resultant applied loads as defined in Section 4.3.

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The following individual connection components will be evaluated as deemed necessary.

Bolted connections:

1. Bolt shear
2. Bolt bearing on connecting material
3. Weld between clip angle or plate and the supporting member
4. Shear on the net area of the clip angles or connection plate
5. Edge distance of the bolt

6. Web tear out (block shear)

7. Combined shear and tension on the bolts.

Moment Connections between Beams and Columns:

1. Column or beam web panel - shear

2. Column or beam web stiffeners will be checked against buckling

3. Welds.

8.0 REFERENCES

1. Balance of Plant Structures Seismic Reevaluation Criteria for SONGS-1, dated February 17, 1981.

2. Return To Service Design Criteria for SONGS-1, "Impact of Pipe Support Loads on Structures," Document M-37458 Revision 1, dated October 10, 1984.

3. "Retrofit General Design Criteria Manual, SONGS-1", Document M-37387 Revision 4, dated December, 1984.

4. NRC Regulatory Guide 1.92.

5. Letter dated March 27, 1985 from D.M. Crutchfield (NRC) to K.P. Baskin (SCE), Docket No. 50-206, No. LS05-85-03-29, Subject: Seismic Criteria and Methodology, SONGS-1.

6. AISC Manual of Steel Construction, 8th Edition, 1980.

7. "Field Walkdown of Existing Secondary Steel Members,"Impell Project Instruction Number 02, SONGS-1 LTS, Job No. 0310-070-1355.

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ATTACHMENT A

CRITERIA AND METHODS FOR INELASTIC BEAM REEVALUATIONS

A.1 INTRODUCTION

Under the SONGS-1 'Return To Service' (RTS) and 'Long Term Service' (LTS) seismic programs, several structural steel members, which support safety-related piping systems, were shown to be inelastic.

This attachment describes the criteria and methods to be used to more accurately reevaluate the inelastic structural steel beams.

A.2 CRITERIA

The elastic acceptance criteria for the reevaluation of structural steel members are defined in Section 6.1 of this Project Instruction. End connections shall be evaluated per the criteria in Section 7.0.

A.3 METHOD OF ANALYSIS

Existing calculations for those beams, qualified to inelastic criteria, will be reviewed and potential conservatisms used in their inelastic analysis will be identified. Specifically, the following areas will be reviewed:

1. Safety-Related Pipe Support Loads. As part of LTS, all large-bore piping systems evaluated during RTS were not explicitly reanalyzed. The RTS pipe support loads have the following conservatisms:

   - Response spectra have been regenerated for the Turbine Building and Containment Structure as part of LTS. In general, the RTS spectra (used during RTS piping evaluations) are more conservative than LTS spectra. Pipe support dynamic loads may be reevaluated based on the LTS spectra. Justification shall be provided when new loads are obtained by direct scaling.

   - During RTS, the seismic inertia and SAM loading for each individual support was combined by absolute summation. LTS criteria permit the use of SRSS between these loads (Reference A.1). The total pipe support loads will be recalculated using this technique.

2. Use of Actual Cross-Sectional Properties. For some structural steel members, conservative cross-sectional properties were assumed in the evaluation. The existing configuration shows the presence of stiffening members along the length of the beam. The as-built configuration shall be used to reevaluate the member.

3. End Conditions. In general, to maximize the beam moments, pin-ended boundary conditions have been assumed for the beam evaluations. If the beam is continuous over a span or fixed at an end, a reevaluation will be performed to take account for end fixity. When a fixed end condition is used, the end connections shall be checked to elastic criteria.

4. Combination of Pipe Dynamic Loads. In general, beam responses resulting from different piping systems' dynamic loads are combined using the absolute summation method. This is based on the conservative assumption that the different piping systems are excited in phase. In lieu of this approach, the dynamic responses may be combined using the SRSS technique (see Reference A.2). Whenever this approach is used, justification that the piping frequencies are not closely-spaced shall be provided.

5. Weak Axis Load Paths. Generally, weak axis bending moments have been conservatively evaluated considering the total beam span. Bracing systems between beams and torsional assemblies with shear studs attached to the concrete slab were neglected. When credit for bracing or torsional assemblies is taken, they will be reevaluated for the imposed loads.

A.4 REFERENCES

1. "SONGS-1 Seismic Program for Long Term Service," Impell Report No. 01-0310-1368, Revision 1, March 8, 1985.

2. USNRC Regulatory Guide 1.92.