Robert L. Cloud and Associates, Inc.

RLCA

Interim Technical Report

DIABLO CANYON UNIT 1
INDEPENDENT DESIGN VERIFICATION PROGRAM
SMALL BORE PIPING REPORT
ITR #30 REVISION 0

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Project Manager/Date
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Small Bore Piping Report

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TELEDYNE ENGINEERING SERVICES

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DIABLO CANYON NUCLEAR POWER PLANT - UNIT I

INDEPENDENT DESIGN VERIFICATION PROGRAM

INTERIM TECHNICAL REPORT

SMALL BORE PIPING

This is the thirtieth of a series of Interim Technical Reports prepared by the DCNPP-IDVP for the purpose of providing a conclusion of the program.

This report contains the results of the IDVP evaluation of span rules and sample field verification, IDVP concerns, and conclusions for the initial sample on small bore piping. All EOI files initiated for the small bore piping have been closed or combined with another error file.

As IDVP Program Manager, Teledyne Engineering Services has approved this ITR-30 including the concerns and conclusions presented. The methodology followed by TES in performing this review and evaluation is described in Appendix E to this report.

ITR Reviewed and Approved
IDVP Program Manager
Teledyne Engineering Services

R. Wray
Assistant Project Manager

1.0 INTRODUCTION

Purpose and Scope

This interim technical report summarizes the independent design verification program (IDVP) review of small bore piping qualifications (span rules) for the Diablo Canyon Nuclear Power Plant (DCNPP). For this effort, small bore piping is defined as all Design Class I piping qualified by span rules regardless of size. The IDVP reviewed the span rules to establish that piping systems supported in accordance with these rules satisfy the licensing criteria. The implementation of the span rules was then evaluated by field verification of approximately 450 feet of small bore piping.

This report is one of many interim technical reports. Interim technical reports include: analytical references, results, sample definitions and descriptions, methodology, a listing of Error and Open Item Reports, an examination of trends and concerns, and a conclusion, as discussed in the June 10, 1982 Nuclear Regulatory Commission (NRC) meeting in Waltham, Massachusetts.

Included with the above items, this report presents the results of the verification of the span rules, and the field verification of the sample. It lists Error and Open Item Reports that have been issued and is intended to serve as a vehicle for Nuclear Regulatory Commission (NRC) review.

Background

On September 28, 1981, PGandE reported that a diagram error had been found in a portion of the seismic qualification of the Diablo Canyon Nuclear Power Plant. This error resulted in an incorrect application of the seismic floor response spectra for sections of the annulus of the Unit 1 containment building. The error originated when PGandE transmitted a sketch of Unit 2 to a seismic service-related contractor. This sketch contained geometry incorrectly identified as Unit 1 geometry.

As a result of this error, a seismic reverification program was established to determine if the seismic qualification of the plant was adequate for the postulated Hosgri 7.5M earthquake. This program was presented orally to the NRC in a meeting in Bethesda, Maryland on October 8, 1981.

At an NRC meeting on November 3, 1981 Robert L. Cloud and Associates (RLCA) orally presented preliminary results and described a revision to the review program based on independent calculations. RLCA presented a preliminary report for the Seismic Reverification Program to the NRC on November 12, 1981 (Reference 1). The NRC Commissioners met during the week of November 16, 1981 to review the preliminary report and the overall situation. On November 19, 1981 an Order Suspending License CLI-81-30 was issued which suspended PGandE's license to load fuel and conduct low power tests up to 5% of rated power at DCNPP-1. This suspending order also specified that an Independent Design Verification Program be conducted to assure that the plant met the licensing criteria.

PGandE retained Robert L. Cloud and Associates as program manager to develop and implement a program that would address the concerns cited in the Order Suspending License CLI-81-30. Phase I plan for this program was transmitted to the NRC on December 4, 1981 and discussed on February 3, 1982. Phase I deals with Hosgri related activities performed by PGandE and seismic service-related contractors prior to June 1978.

On March 19, 1982 the NRC approved Teledyne Engineering Services (TES) as program manager to replace Robert L. Cloud and Associates. However, RLCA continued to perform the independent review of seismic, structural and mechanical aspects of Phase I.

The NRC approved the Independent Design Verification Program Phase I Engineering Program Plan on April 27, 1982. This plan dictates that a sample of piping, equipment, structures and components be selected for independent analysis. The results of these verification analyses are to be compared to the design analyses results. If the acceptance criteria is exceeded, an Open Item Report is to be filed. Interim technical reports are to be issued to explain the progress of different segments of the technical work.

<u>Summary</u>

The IDVP completed the following tasks in the verification of small bore piping for the Hosgri event:

- o A review of the span rules used for the qualification of small bore piping systems against the licensing criteria, and
- o A field verification of the implementation of span rules used for selected small bore systems.

The span rules were found to generally satisfy the licensing criteria and to be correctly implemented. Five generic concerns were noted (see Section 5.0), and these will be addressed following the Diablo Canyon Project corrective action program. This program specifies computer analysis, rather than use of span rules, for all piping larger than 2 inches.

2.0 SMALL BORE PIPING DESIGN METHODOLOGY

The following section presents a description of the span rules originally used for the qualification of small bore piping systems to the licensing criteria.

2.1 LICENSING CRITERIA

The following DCNPP-1 licensing documents specify the criteria and commitments:

- o Final Safety Analysis Report (FSAR) - which contains the original plant requirements (Reference 2).

- o Hosgri Report - which contains licensing criteria specific to the Hosgri evaluation of the plant (Reference 5).

The FSAR lists the original requirements for piping including governing codes for the various design piping classes. The FSAR references USAS B31.1 1967 Edition with 1971 Addenda (Reference 3) and USAS B31.7, 1969 Edition (Reference 4) for Code Class I, II and III piping.

The Hosgri report cites a 1969 J.A. Blume report (Reference 6) to confirm the conservatism of this span rule approach. This report was reviewed by the IDVP for background information. EOI 1059 was issued to note that this report does not address span rule conservatism.

The Hosgri Report additionally specifies stress allowables, load combination equations and stress computation methods which are from ANSI B31.1 1973 Edition through Summer 1973 Addenda ANSI B31.1b (Reference 7) or later editions.

The IDVP calculated stresses based on Equation 12 of ANSI B31.1b 1973. The stresses were then combined and compared to the allowables of ANSI B31.1, 1973 Edition.

Primary stresses (i.e., pressure, deadweight, and Hosgri) were evaluated by using Equation 12:

$$\frac{PD_o}{4t_n} + \frac{0.75iM_A}{Z} + \frac{0.75iM_B}{Z} \leq KS_h$$

Where,

P = Internal design pressure, psig

D_o = Outside diameter of pipe, inches

t_n = Nominal wall thickness of component, inches

M_A = Resultant moment loading on cross section due to sustained loads, in-lb.

M_B = Resultant moment loading on cross sections due to occasional loads, in-lb.

i = Stress intensification factor (SIF)

Z = Section modulus, inches^3

K = 2.4, for faulted conditions

S_h = Basic material allowable stress at maximum (hot) temperature

2.2 SPAN RULES

A large number of Design Class I piping systems in the Diablo Canyon Nuclear Power Plant were qualified by the use of span rules. These rules specified maximum pipe spans and provide guidelines for the placement of supports.

Span rules were used to perform, control and document the qualification of two groups of pipe: The first group of 2 inch and smaller piping was field routed; the second group of 2 1/2 to 6 inch piping was office designed.

The 1/2 to 2 inch piping systems were qualified by PGandE Drawing No. 049243 "Pipe Supports for Field Run, Design Class 1 Piping Diablo Canyon" (Reference 8). This document established the rules for support placement, including offset configurations and typical support design requirements.

The 2 1/2 to 4 inch piping was qualified by PGandE Drawing No. 049239 "Pipe Support Spans for Non-Analyzed Class 1 Piping Diablo Canyon" (Reference 9). This document established allowable seismic spans and specified a reduction of spans at bends and near valves.

The Hosgri Report Section 8.1.1 allows for qualification of 6 inch piping by span rules. However, no span rules were found for this piping.

The methodology, implicit in both sets of span rules discussed above, involves limiting the seismic response of piping systems by controlling the length of spans between seismic supports. The seismic response between orthogonal runs of pipe is decoupled either by placement of supports near changes in direction or by the axial support of straight runs of pipe with welded attachments (lugs). The methodology is based on using enveloped Hosgri floor response spectra with 2% damping and maximum floor eccentricities. In addition, the first mode of vibration of the piping system is required to be less than .066 seconds (>15 hertz).

- Both sets of span rules require that "engineering judgment" be exercised by field and office staff for implementation because the span rules do not address all possible piping configurations.

3.0 IDVP REVIEW OF SMALL BORE PIPING

3.1 IDVP PROCEDURES AND ACCEPTANCE CRITERIA

The verification of small bore piping consisted of two parts:

- o Review of the span rules to establish that piping systems supported in accordance with these rules satisfy the licensing criteria, and
- o Field verification of a sample to establish that the pipe installation conforms to the span rules.

3.2 SAMPLE SELECTION

The following IDVP selection criteria were established for selection of the piping samples:

- o Pipe sizes qualified by each of the span rules, and
- o Pipe sizes which were widely used.

Pipes with 6 inch diameters and all sizes of insulated lines were excluded from the IDVP review because neither of the span rules addressed these items (EOI 1059). These items will be reviewed by the IDVP as part of verifying the DCP corrective action program.

The IDVP selected two samples: one sample to verify the span rules, the other to verify the implementation of the span rules.

3.2.1 Span Rule Sample

The span rules (discussed in Section 2.2) were reviewed to establish the parameters to be used for the small bore piping sample selection. The following parameters were considered: pipe size, material properties, design temperatures, pressures, and natural frequencies.

3.2.1.1 Sizes and Schedules

Table 1 presents the sizes and schedules reviewed by the IDVP. The sample sizes 2, 3 and 4 inch were selected because they are widely used. Schedules 10S and 40 were selected because the maximum allowed spans gave the lowest frequencies (as determined in Section 3.2.1.5). These low frequencies yield maximum acceleration values and maximum stresses.

3.2.1.2 Materials

The following piping materials are listed in Design Criteria Memorandum M-9 (Reference 10):

- o Carbon steel ASTM A53, Grades A and B
- o Carbon steel ASTM A106, Grade B
- o Stainless steel ASTM A312, Types 304 and 316
- o Stainless steel ASTM A358, Type 304
- o Stainless steel ASTM A376, Type 304

The IDVP determined that the material properties which are lower bounds for these pipe materials (including temperature considerations) are the following (Reference 28):

- o Allowable stress (S_h) = 12,000 psi
- o Modulus of elasticity (E) = 27.7×10^6 psi

Piping	Nominal Diameter (inches)	Schedule[a], [b]
Field Run Design Class 1 (PGandE Drawing No. 049243)	1/2	10S, 40, 80, 160
	3/4	10S, 40, 80, 160
	1	10S, 40, 80, 160
	1-1/4	10S, 40, 80, 160
	1-1/2	10S, 40, 80, 160
	2	10S, 40, 80, 160
Non-analyzed Design Class 1 (PGandE Drawing No. 049239)	2-1/2	5S, 10S, 40, 80 160, XXS
	3	10S, 40, 80, 160 XXS
	4	10S, 40, 80, 120 160, XXS
	6[c]	10S, 40, 80, 120 160, XXS

Note: (a) - Field Run Piping schedules were assumed consistent with Design Criteria Memorandum (DCM) M-9 (Reference 10).

(b) - Non-analyzed Piping Schedules were as per Drawing No. 049239. DCM M-9 and the Hosgri Report exclude schedule 5S.

(c) - Per Hosgri Report and FSAR. Spans not shown on Drawing No. 049239.

Table 1

Small Bore Piping
Nominal Diameters and Schedules

3.2.1.3 Temperatures

The IDVP reviewed the FSAR and Hosgri Report and determined that both "cold" and "hot" piping could be qualified by span rules (Reference 5, Section 8.1.2). However, the span rules only covered uninsulated piping (EOI 1059). Therefore, the IDVP selected uninsulated piping for evaluation and used the "hot" temperatures, listed below, to conservatively determine the allowable stress S (see Section 3.2.1.2):

- "Field-Run Design Class I Piping" (1/2 to 2 inches) - "cold" and "hot"
  - 165 degrees F, stainless steel
  - 200 degrees F, carbon steel
- "Non-Analyzed Design Class I Piping" (2 1/2 to 4 inches) - cold*

*Temperatures were not found to be specified by the span rules for non-analyzed piping (EOI 1059). The piping in these sizes was described as cold in the Hosgri Report (Reference 5).

3.2.1.4 Pressures

For the previously selected pipe sizes and schedules, maximum pressures were determined (Reference 24) from review of DCM M-9 (Reference 10).

Pipe Size	Schedule	
	10S	40
2"	50 psig	700 psig
3" and 4"	255 psig	1085 psig

3.2.1.5 Frequencies

The IDVP sample selection process included calculating the natural frequencies of spans for 1/2 to 4 inch pipe sizes (Reference 25). The IDVP calculations used closed form solutions for simply supported, multi-span pipes. Computer calculations were later made which verified these closed form solutions and examined other configurations (References 30 to 51).

The IDVP calculations showed the first mode natural frequencies to be below 15 hertz for 2 inch pipe (Models 1, 2, 3, and 4) and 3 inch and 4 inch pipe (Model 3). These models are described in Section 3.3.3. EOI 1059 notes that the 1977 PGandE Hosgri Reevaluation Report (Reference 11) showed piping overstress. In conjunction with this, the report also indicated piping configurations with frequencies below those required by the Hosgri Report (15 hertz).

3.2.2 Field Verification Sample

A sample of three runs of small bore piping (about 150 feet each) was chosen for field verification. This length of piping included more than twenty supports. The selected sample of piping is shown on PGandE piping isometric drawings (References 22 and 23).

The span rules provided a simple standard implementation. Therefore, the IDVP field verification of the limited sample provided a verification of span rule implementation. Complex piping configurations that were not specifically addressed in the span rules (i.e., situations resolved by engineering judgment) were not addressed by the IDVP field verification. ITR #1, Revision 1, "Additional Verification and Additional Sampling", notes that this portion of the review will be included in the verification of the DCP corrective action program.

3.3 ANALYSES

The IDVP analysis of small bore piping span rules evaluated three loadings: pressure, gravity and Hosgri earthquake. For each type of loading, the methods, assumptions, and results are presented.

In addition, the verification analyses addressed the effects of welded attachments.

3.3.1 Pressure

Longitudinal pressure stresses (S_{LP}) were calculated by using the expression:

$$S_{LP} = \frac{Pd^2}{D^2-d^2}$$

where, P = Design pressure, psig
d = Pipe inside diameter, inch
D = Pipe outside diameter, inch

The design pressures were selected in accordance with Section 3.2.1.4 for each pipe size and schedule. The pressure stress results for the selected pipe samples are presented in Table 2 (and in Reference 24).

3.3.2 Gravity

Gravity stresses were computed based on the maximum spans for the selected pipe sizes and schedules (References 27 and 30 to 51). Analyses were performed using the ADLPIPE computer program (see Appendix B) for the four models shown in Figure 1. Additional descriptions of the computer models is provided in Section 3.3.3. The gravity stress results are presented in Table 2.

3.3.3 Hosgri Earthquake Loadings

To determine locations of small bore piping qualified by span rules, the IDVP reviewed general plant arrangements, piping design isometrics and piping system descriptions. Based on these reviews, an envelope was developed for 2% damped spectra for elevations at or below elevation 140 feet in the containment and the auxiliary buildings (Reference 26).

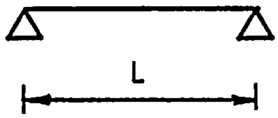
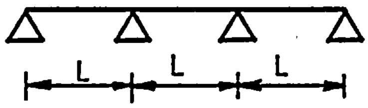
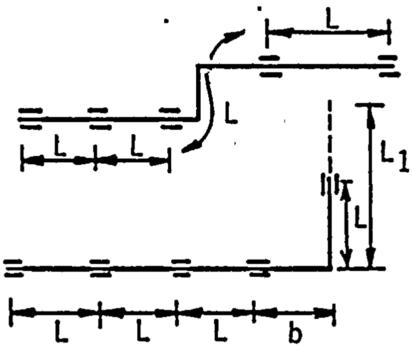
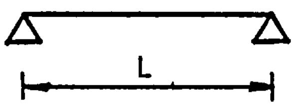
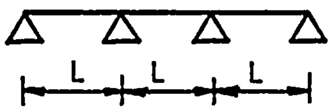
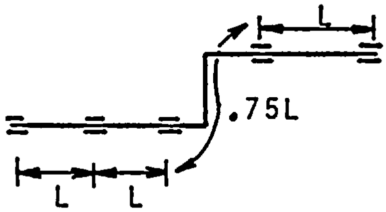
Piping	Model No.	Model	Description
2 inch Schedules 10S and 40	1		Single simple maximum span
	2		Three simple maximum spans
	3		Multiple span with 2 changes of direction (per Reference 8)
	4		Offset case (per Hosgri Figure 8-1) L_1 = maximum run length b = offset support distance
3 and 4 inch Schedules 10S and 40	1		Single simple maximum span
	2		Three simple maximum spans
	3		Multiple spans with 2 changes of direction (per Reference 8)

Figure 1

Small Bore Piping Configurations Considered in IDVP Analyses

Pipe Size (inches)	Schedule	Pressure Stress (psi)	Model 1 1 Span (psi)	Model 2 3 Span (psi)	Model 3 Direction Change (psi)	Model 4 L_1 Leg=10 ft. Horizontal (psi)	Model 4 L_1 Leg=100 ft. Horizontal (psi)
2	10S	235	2279[(a)] 24052[(b)] 26331[(c)]	1898 11766 13124	2064 14328 16196	2039 13492 14826	1952 14529 16211
2	40	2186	2068 20609 22677	1723 10394 11890	1873 12875 14598	1851 12107 13317	1772 12891 14417
3	10S	1670	1840 15318 17159	1533 9037 10570	1691 10573 12264		
3	40	3600	1666 13847 15513	1388 8181 9568	1546 10163 11709		
4	10S	2200	1955 16341 18296	1628 9606 11235	1796 11000 12796		
4	40	4352	1701 14185 15886	1417 8366 9783	1577 10257 11834		

Explanation of Rows

a. Maximum deadweight
b. Maximum seismic
c. Seismic and deadweight
d. SIF = 2.1 (2" pipe)
   = 1.8 (3, 4" pipe)

Table 2

Stress Analysis Results[(d)] (Without Lugs)

Horizontal spectra for buildings with torsion were prepared using the maximum building eccentricity. These spectra were enveloped with other building horizontal spectra. The horizontal and vertical spectra envelopes that were used are shown in Figures 2 and 3.

The IDVP did not explicitly include spectra for the following areas in the spectra envelope: turbine building, intake structure, and areas above elevation 140 feet in the containment and auxiliary buildings. These areas were excluded for the following reasons. Small bore piping in the turbine building and intake structure would, in general, be located in areas (i.e., lower elevations of these structures) for which the spectra is within the envelope. For several areas in the containment and auxiliary buildings above elevation 140 feet, spectra had not been generated (e.g., EOI 1009). Therefore, the IDVP spectra envelope provided for an adequate evaluation. The IDVP will verify that the DCP corrective action program allows installation of small bore piping only in areas where the corresponding spectra is considered in the span rules.

The Hosgri earthquake and gravity loadings were evaluated for the sample sizes using ADLPIPE computer models. The four models which were developed are shown in Figure 1 (and Reference 29). The models consider both the piping spans and the change in direction configurations specified by the span rules.

- o Models 1 and 2 were selected to evaluate the adequacy of the span rules for inertial earthquake loadings that are orthogonal to the pipe. The results from Model 2 were also used to approximate a run of pipe axially supported by a welded attachment (lug).

- o Model 3 was selected to evaluate the effects of asymmetrical response in systems with multiple changes in direction.

- Model 4 was selected to evaluate the response of orthogonal runs of piping which are restrained with a support near the change in direction. The distance between the support and change in direction (distance "b") was determined by the span rules. This support acts to axially restrain the piping run (distance "L_1"). As a bound of this run length, results were obtained for L_1 = 10 feet and 100 feet (maximum allowed by span rules). This model was not evaluated for 3 and 4 inch piping because the span rules for these pipe sizes did not specifically limit the unsupported distance from a change in direction.

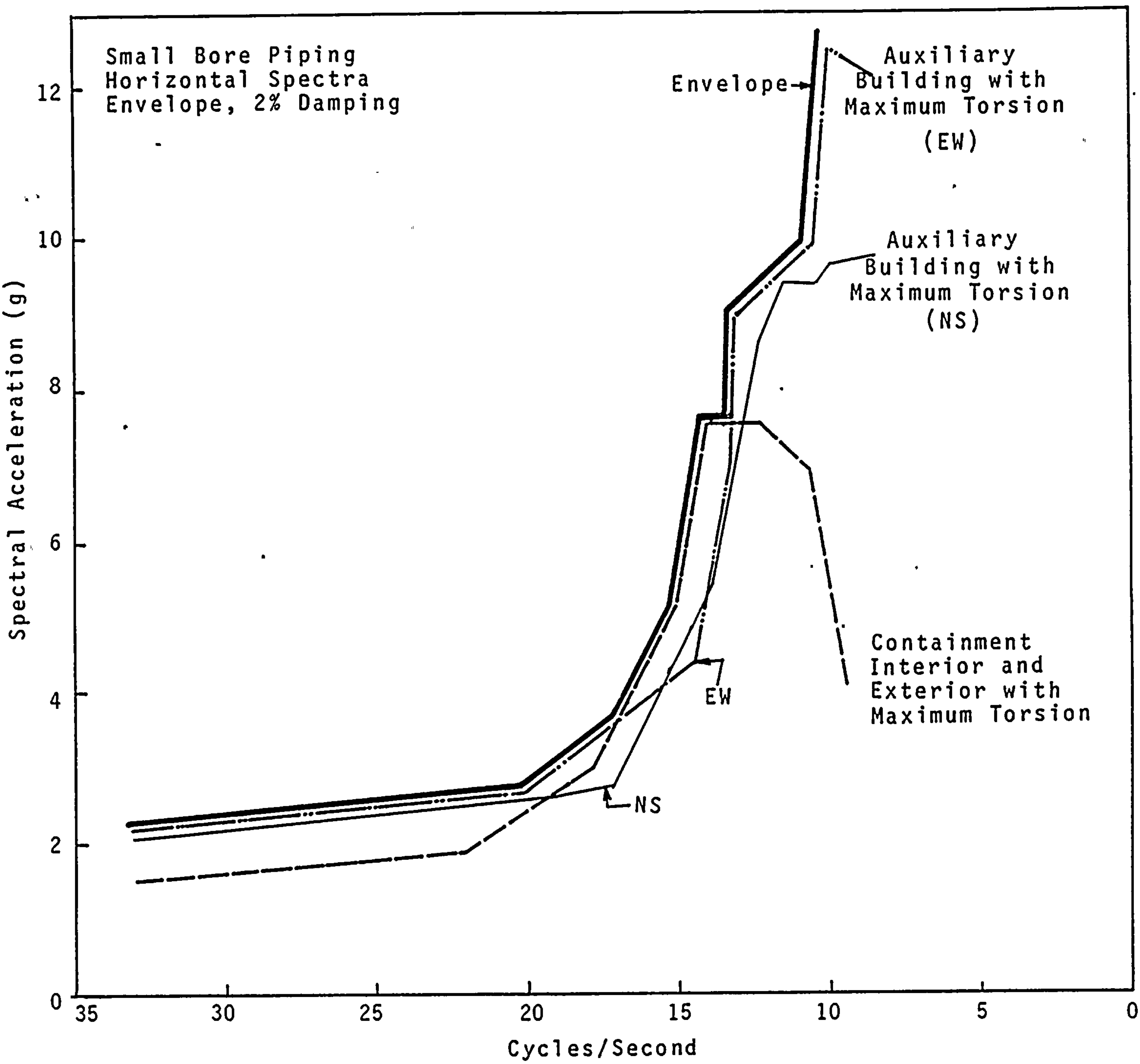
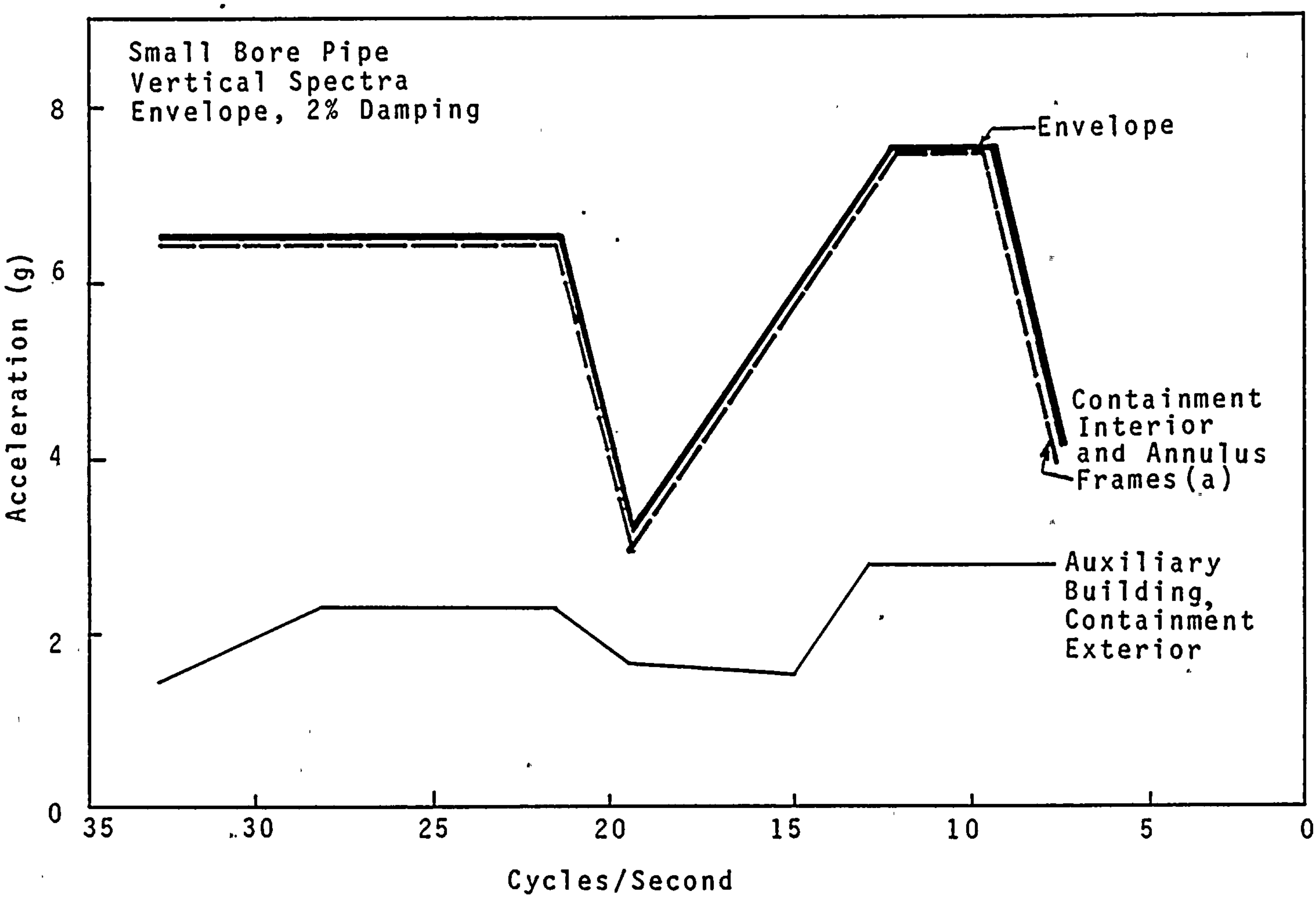


Figure 2

Horizontal Spectra Envelope



(a) Reference 14

Figure 3

Vertical Spectra Envelope

Where changes in direction occur, the elbows were assumed to be socket welded fittings for 2 inch lines and long radius elbows for 3 and 4 inch lines. A stress intensification factor (SIF) of 2.1 was used for socket welds on 2 inch lines; an SIF of 1.8 was used for butt welds (assumed "as-welded") on 3 and 4 inch lines.

The analyses were performed by using the envelope spectra with a 33 hertz frequency cut off (Reference 5). The horizontal and vertical earthquake responses on a modal level were combined by using absolute summation, and then modal responses were combined by using the square root of the sum of the squares (SRSS). Maximum seismic stress results for the sample sizes are shown in Table 2 (References 27, 29, and 30 to 51).

The results (seismic stresses only) from Table 2, Model 1, were compared to those presented by the PGandE report on the reevaluation of Hosgri seismic stress in piping supported by the span rules (Reference 11). Model 1 results (simply supported, single span) were chosen for comparison to be compatible with those presented in the referenced report. The effects of pressure, gravity, and lugs were not included in the comparison. Table 3 presents the results of this comparison.

3.3.4 Welded Attachments

The span rules allowed for the use of welded attachments (lugs) to provide axial support. This axial support decouples the response of adjacent orthogonal runs of piping. The effects of axially restraining the pipe with lugs were evaluated by the following two steps:

1) A field review was performed of the axial lug support designs contained in a sample of small bore piping isometrics. The results indicated that "common" welded lug attachment dimensions (Width x Height x Length) were 1/2 x 3/4 x 1 inch for 2 inch lines and 1/2 x 3/4 x 1 1/2 inches for 3 and 4 inch lines. The support designs allowed seismic action of either one or two lug attachments on a run of pipe (see Figures 4 and 5).

Pipe Size (inches)	Schedule	Reevaluation		IDVP	
		Seismic Stress (ksi)	Ratio to Allowable (a)	Seismic Stress (ksi) (b)	Ratio to Allowable (a)
2	40	27.88	0.92	20.61	0.68
3	40	26.30	0.87	13.85	0.46
4	40	28.87	0.98	14.19	0.48

Note: a. For this comparison, S_h = 15,000 psi
Seismic allowable stress = 2.4 $S_h - S_G - S_P$
S_G = 1.50 ksi (assumed uniform deadweight stress)
S_P = Design pressure stress

b. IDVP seismic stresses are based on a simply supported, single span model (Model 1, Table 2).

Table 3

Comparison of Seismic Stress
(PGandE Hosgri Re-evaluation and IDVP)

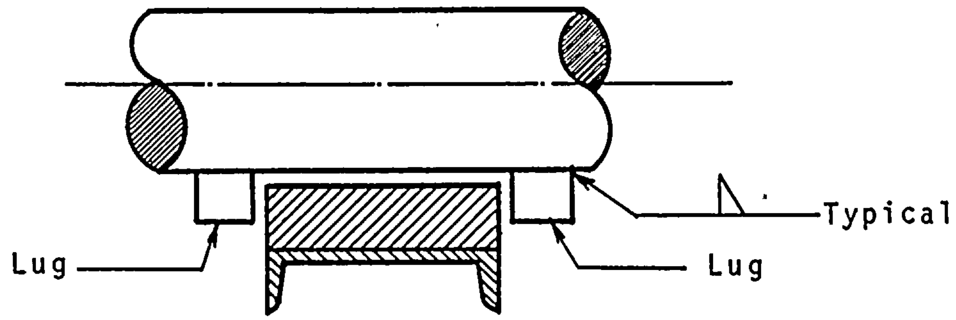


Figure 4

Single Lug Design

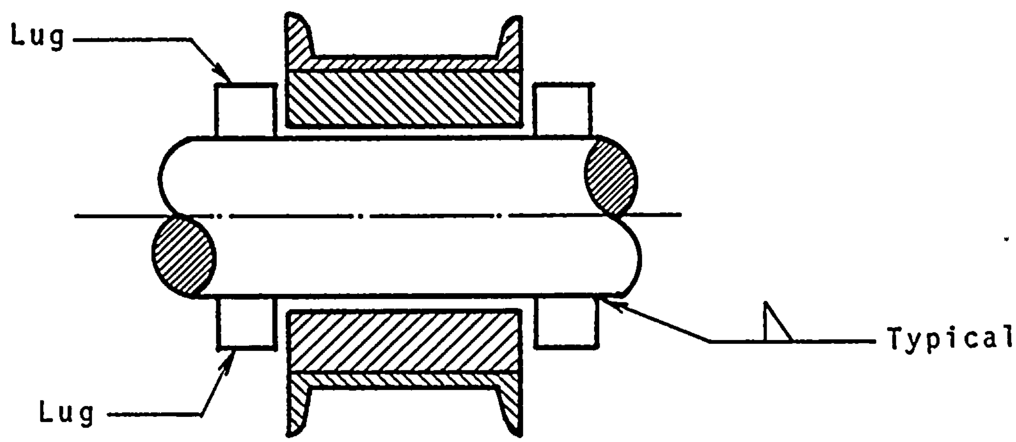


Figure 5

Double Lug Design

2) An analysis of the local stresses induced in the pipes by lugs was performed (Reference 28) using the method presented by K.R. Wichman, et al. in the "Welding Research Council Bulletin 107" (WRC-107) (Reference 12). This analysis assumed worst-case configurations of 100 feet of horizontal, axially restrained pipe and 50 feet of vertical, axially restrained pipe. The piping was subjected to the enveloped horizontal and vertical spectra accelerations at 20 hertz for the axial mode of response.

In calculating local pipe stresses due to a lug, using the WRC-107 method, the primary lug stress components (i.e., primary membrane and shear) were determined. Using standard formulas shown in the tables, these components were combined with each other (Table 4) and with pressure, gravity, and seismic (longitudinal) loads (Table 6) to form principal stresses.

The results of this analysis are presented in Table 4 for a one lug support configuration. The lug stresses for a 50 foot run of vertical pipe were found to be higher than the lug stresses for a 100 foot run of horizontal pipe. The 50 foot vertical run length for all sizes and the 100 foot horizontal run length for greater than 2 inch pipe were IDVP assumptions. These assumptions will be verified as part of the IDVP review of DCP corrective action.

Pipe Size (inches) (a)	Schedule	Lug Primary Membrane Stress (ksi) (b)	Lug Shear Stress (ksi) (b)	Combined Lug Primary Stress (ksi) (c)
2	10S	6.64	6.92	11.00
	40	4.01	5.92	8 26
3	10S	7.38	7.89	12.40
	40	2.77	5.95	7.49
4	10S	10.10	11.70	17.79
	40	3.50	8.20	10 13

Note: (a) Lug size for 2" pipe = 1/2 x 3/4 x 1";
for 3" and 4" pipe = 1/2 x 3/4 x $1\frac{1}{2}$"

(b) Maximum lug stress due to axial seismic excitation only is from 50 foot vertical run configuration.

(c) Lug primary membrane stress is combined with lug shear stress using the formula

$$1/2\ [(\text{Primary Membrane}) + \sqrt{(\text{Primary Membrane})^2 + 4(\text{Shear})^2}]$$

Table 4

Maximum Lug Stresses
(One Lug Configuration)

3.3.5 Loading Combinations

The stresses resulting from loadings due to pressure, gravity, Hosgri earthquake, and the effects of welded attachments, (determined in Sections 3.3.1 to 3.3.4) were combined in accordance with the licensing criteria.

Normal and faulted loading conditions were evaluated as described below.

Normal Conditions

The stress requirements for normal conditions are as follows:

$$S_G + S_{LP} \leq 1.0 S_h = 12{,}000 \text{ psi}$$

where, S_G = Gravity stress

S_{LP} = Longitudinal pressure stress

The results of the IDVP evaluation indicate that gravity plus pressure stresses for all sample sizes and schedules were found to be less than the allowable stresses (1.0 S_h). Therefore, the small bore span rules satisfy normal loading conditions.

Faulted Conditions

The stress requirements for faulted (Hosgri) loadings are as follows:

$$S_G + S_{LP} + S_{HE} + S_{ISA} \leq 2.4 S_h = 28{,}800 \text{ psi}$$

where, S_{HE} = Hosgri 7.5M stress

S_{ISA} = Integral structural attachment stress in pipe due to inertial seismic and deadweight loadings.

The evaluation of faulted condition loads was performed for two cases. Both cases included the combination of stresses resulting from pressure, gravity and Hosgri earthquake loadings.

The first case evaluated the configurations represented by the four models shown in Figure 1. The maximum stresses occurred for Model 1 (single span) with SIF = 2.1 for 2 inch pipe and SIF = 1.8 for 3 and 4 inch pipe. These results are presented in Table 5.

The second case evaluated a straight run of pipe with 1 or 2 lugs that are not attached close to a circumferential weld (SIF = 1.0). Since lugs were used on long runs of pipe that require axial support, the three span model (Model 2) was used to determine corresponding gravity and seismic stresses. The results for both 1 and 2 lug support configurations are presented in Table 6 and in Reference 28.

Pipe Size (inches)	Schedule	Pressure Stress (ksi)	Gravity Stress (ksi) (a)	Hosgri Stress (ksi) (a)	Combined Stress at Weld (ksi)	Ratio to Allowable (b)
2 2	10 40	0.24 2.19	2.28 2.07	24.05 20.61	26.57 24.87	0.92 0.86
3 3	10 40	1.67 3.60	1.84 1.67	15.32 13.85	18.83 19.12	0.65 0.66
4 4	10 40	2.20 4.35	1.96 1.70	16.34 14.19	20.50 20.24	0.71 0.70

Note:

(a) Maximum stress among all models in Table 2 (Model 1)
SIF = 2.1 for 2" pipes; 1.8 for 3" and 4" pipes

(b) Allowable stress = 28.8 ksi

Table 5

Maximum Combined Stresses
(without Lugs)

Pipe Size (inches)	Schedule	Pressure Stress (ksi)	Gravity Stress (ksi) (a)	Hosgri Stress (ksi) (a)	Lug Stress		Combination[b] of Longitudinal and Shear Stress at 1 Lug (ksi)	Ratio to Allowable (d)	Combination[c] of Longitudinal and Shear Stress at 2 Lugs (ksi)	Ratio to Allowable (d)
					Primary Membrane (ksi)	Shear (ksi)				
2	10	0.24	1.21	7.47	6.64	6.90	18.18	0.63	13.15	0.46
2	40	2.19	1.09	6.60	4.01	5.90	16.06	0.56	12.62	0.44
3	10	1.67	1.14	6.69	7.38	7.90	20.00	0.69	14.28	0.50
3	40	3.60	1.03	6.06	2.77	5.95	15.71	0.55	12.77	0.44
4	10	2.20	1.21	7.12	10.1	11.7	25.91	0.90	17.53	0.61
4	40	4.35	1.05	6.20	3.50	8.20	18.70	0.65	14.51	0.50

Note:

a. Lug is assumed to be located on a straight pipe, sufficiently removed from a weld point. Stresses are based on Model 2 (3 span model) with SIF = 1.0

b. Combination of $1/2\left[(\text{Longitudinal Stress}) + \sqrt{(\text{Longitudinal Stress})^2 + 4(\text{Lug Shear Stress})^2}\right]$ where, Longitudinal Stress = Pressure + Gravity + Seismic + Lug Membrane Stress

c. For 2 lug configuration, lug stress components (i.e., primary membrane and shear) are divided by 2 and combined with other longitudinal stresses as in (b).

d. Allowable = 2.4 S_h = 28.8 ksi

Table 6

Maximum Combined Stresses (with Lugs)

3.4 FIELD VERIFICATION

The field verification of the three runs of small bore piping (about 150 feet each) specifically addressed the following:

- o Conformance of "as built" conditions to span rules. Initially, the IDVP reviewed the field installations considering the 79-14 walkdown tolerances (Reference 13). However, since this Bulletin does not apply to noncomputer analyzed piping, the final IDVP acceptance criteria were the span rules (References 8 and 9).

- o Documentation of support types and locations and other dimensions.

- o Reasonableness of IDVP analysis assumptions on component stress intensification factors, lug details, insulation and axial pipe runs.

3.5 ERROR AND OPEN ITEM REPORTS

EOI 1024 was issued to note a single support for six lines that was labeled both 85S/40V and 85S/40R on the design isometric (V = spring, R = rigid). This item has been closed because of the DCP commitment to perform walkdowns of all Design Class I piping larger than 2 inches.

EOI 1043 was issued to note support location differences between the field condition and the design isometric. This item has been resolved as a deviation because the pipe support design analyses are consistent with the field condition.

EOI 1044 was issued to note that design isometric 446548 Revision 8 did not indicate supports on lines 3674, 1478, 3673 and 1477. This item has been closed following receipt of specific isometrics for small bore piping that correctly indicate these supports.

EOI 1045 was issued to note a difference between the field condition (three-directional support) and the design isometric (two-directional support). This item has been closed as a deviation because the design pipe support analysis agrees with the field condition.

EOI 1046 was issued to note a dimensional difference between the field condition and the design isometrics. This item has been closed as a deviation because the field conditions agree with the span rules.

EOI 1047 was issued to note that design isometric 447115 Revision 6 did not indicate supports on lines 32, 1550 and 30. This item has been closed following receipt of specific isometrics for small bore piping that correctly indicate these supports.

EOI 1048 was issued to note that a span on line 52 did not meet the span tables. This item has been closed following notification that line 52 was qualified by computer analysis not span rules.

EOI 1058 was initially issued to note stresses for certain one and two lug configurations that exceed allowables assuming a maximum pipe span. Further analysis showed all stresses to be below the allowables. This item has been combined with EOI 1098 as a Class A or B Error.

EOI 1059 was issued to note three discrepancies:

- o The PGandE report (Reference 11) shows certain pipe stresses above the allowable. (Frequencies below 15 hertz are also shown in this report.)

- o The 1969 preliminary Blume report (Reference 1), does not address span conservatism, as implied in the Hosgri Report (Reference 5).

- o The span tables do not address insulation weight or 6 inch piping.

This EOI is combined with EOI 1098 as a Class A or B Error.

4.0 INTERPRETATION

4.1 IDVP FIELD VERIFICATION

The results of the field verification initially indicated that documentation for small bore piping and support qualification contained certain discrepancies associated with the control of hanger types and location. The items noted below were a result of the IDVP using the large bore piping isometrics (Reference 22) that also showed small bore piping.

- o Hangers were found in the field that were not marked (EOIs 1044 and 1047).
- o Design isometrics did not agree with field conditions (EOIs 1043 through 1047).

These items were resolved upon later review of isometric drawings that specifically applied to small bore piping (Reference 23). Also, as-built isometrics were not required for noncomputer analyzed Design Class I piping by the IE Bulletin 79-14, Revision 1.

Although the licensing criteria does not require that hangers be field marked, the IDVP considers this good engineering practice. Following the DCP corrective action program, the IDVP will verify that the small bore pipe support qualifications are not affected by unmarked hangers.

For the selected sample, the IDVP found that all piping was installed in accordance with the span rules. In addition, pipe routing and support design configurations were observed which were not specifically addressed by the span rules. These situations were resolved by PGandE through the use of undocumented engineering judgment. Use of engineering judgment is considered a normal practice when implementing simplified span rules. The specific use of engineering judgment by PGandE in applying the span rules to small bore piping will be verified by the IDVP following the DCP corrective action program.

4.2 IDVP VERIFICATION ANALYSES

The IDVP verification analyses indicated that pipe stresses for small bore piping, as shown in Tables 4 and 6, meet the licensing criteria for normal and faulted (Hosgri) conditions. The stresses were evaluated for several simple models which represent various piping and support configurations. The maximum stresses were obtained for a single span pipe model without lugs and a three span pipe model with a single lug.

The verification analysis results (single span, seismic stresses only) were compared in Table 3 to those from the PGandE Hosgri reevaluation report (Reference 11). This comparison showed that the PGandE stresses were higher than those calculated by the IDVP. The PGandE results were based on spectral accelerations that were higher than those used by the IDVP. Other reasons for the differences in results were not determined and no specific conclusions were based on this comparison.

In addition, during the sample selection and verification process, frequencies below 15 hertz were noted for several span rule configurations.

5.0 CONCLUSION

The IDVP review of the span rules and the field implementation showed that the rules generally satisfied the licensing criteria and that the small bore piping was installed in accordance with these span rules. The following generic concerns were noted:

- The span rules do not address insulated piping.
- The span rules do not limit the areas where small bore piping is installed. The span rules may not satisfy the licensing criteria for all areas of the plant (i.e., all high response spectra areas).
- The Hosgri Report specifically allows the support of 6 inch piping using span rules, however, this pipe size was not addressed in the span rules. Also, the Hosgri Report does not prohibit the support of piping larger than 6 inches by the use of span rules.
- The piping first mode frequencies resulting from use of the span rules are less than 15 hertz (licensing criteria) for certain piping sizes and configurations.
- For 3 and 4 inch pipe, the span rules do not specifically limit the unsupported distance from a change of direction containing a run of pipe that requires axial restraint.

In addition, one specific concern was noted:

- While the Hosgri Report implies that the 1969 J.A. Blume report (Reference 6) demonstrates the conservatism of the span rule approach, the IDVP found no evidence to confirm this in the Blume Report.

These six concerns, and the following three items from the original design, will be addressed by the DCP corrective action program and verified by the IDVP.

- Certain piping configurations are supported in the field with the use of undocumented engineering judgements.

- The maximum vertical (all sizes) and horizontal (> 2 inches) runs of pipe are assumed to be 50 feet and 100 feet, respectively.

- Certain hangers in the field are not marked. Although the licensing criteria does not require that hangers be field marked, the IDVP considers this to be good engineering practice. Following the DCP corrective action program, the IDVP will verify that the small bore pipe support qualifications are not affected by unmarked hangers.

6.0 REFERENCES

Reference No.	Title	RLCA File No.
1	Preliminary Report, Seismic Reverification Program, Robert L. Cloud and Associates, Inc., November 12, 1981.	P105-4-820-005
2	"Diablo Canyon Site Units 1 and 2 Final Safety Analysis Report," USAEC Docket Nos. 50-275 and 50-323.	P105-4-200-005
3	Power Piping, USAS B31.1, 1967 Edition, with 1971 Addenda, American Society of Mechanical Engineers.	
4	Nuclear Power Piping, USAS B31.7 1969 Edition, American Society of Mechanical Engineers.	
5	"Seismic Evaluation for Postulated 7.5M Hosgri Earthquake," USNRC Docket Nos. 50-275 and 50-323.	P105-4-200-001
6	Diablo Canyon Preliminary Report: "Seismic Evaluation of Small Pipes," J.A. Blume, August 5, 1969, JAB-PGE-02.	P105-4-432-001
7	Power Piping, ANSI B31.1, 1973 Edition, through Summer 1973 Addenda ANSI B31.1b, American Society of Mechanical Engineers.	
8	PGandE Drawing No. 049243 Revision 10, "Piping and Mechancial Pipe Supports for Field Run, Design Class 1 Piping Diablo Canyon."	P105-4-432-033
9	"PGandE Drawing No. 049239 Revision 3, "Pipe Support Spans for Non-Analyzed Class 1 Piping."	P105-4-432-048

Reference No.	Title	RLCA File No.
10	"PGandE Design Criteria Memorandum M-9," Revision 4, November 17, 1981.	P105-4-200-003
11	"Hosgri Re-evaluation of the Spacing Criteria for 1/2 to 6 Inch Piping Systems," PGandE Mechanical and Nuclear Engineering File 146.40 and 146.26, November 1977.	P105-4-432-001
12	Welding Research Council Bulletin, 107, K.R. Wichman, A.G. Hopper, and J.L. Mershon, "Pressure Vessels and Piping: Design Analysis," 1972, Edition by Bohn, Cloud, Hsu, Pai and Reedy, ASME.	
13	"PGandE NRC IE Bulletin 79-14 Field Verification Procedure," Revision 2.	P105-4-422-006
14	PGandE Mechanical Nuclear Letter, "Vertical Floor Response Spectra - Containment Annulus," November 28, 1981.	P105-4-200-004
15	"Diablo Canyon Nuclear Power Plant, Independent Design Verification Program, Program Procedure, Phase I Engineering Program Plan," DCNPP-IDVP-PP-001, Revision 0, 3/31/82.	
16	"DCNPP Independent Design Verification Program, Phase I Program Management Plan, Revision 1." July 6, 1982 (Revision 0, April 27, 1982).	P105-4-810-021
17	"Simplified Methods for the Thermal and Seismic Analysis of Small Size Pipes," V. Guiliano, S. Cecconi, R. DuCol, F. Canepa SMIRT Conference 1981.	

Reference No.	Title	RLCA File No.
18	"Field Support of Small-Bore Piping to the Rules of ASME Section III," J.T. Prawlucki, Transactions ANS Volume 33, 1979.	
19	"Survey Report on Structural Design of Piping Systems and Components," TID-25553, December 1970.	
20	"Generic Methods for Design of Small Bore Pipe Supports," G.L. Clark and F.R. LaSalle, PVP Volume 53, ASME 1981.	
21	"Preparation of Open Item Reports, Error Reports, Program Resolution Reports and IDVP Completion Reports", IDVP Program Procedure, DCNPP-IDVP-PP-003, Revision 1, 6/18/82.	
22	PGandE Drawings Piping Isometrics (Large Bore):	
	446548 Revision 8	P105-4-454-214
	447115 Revision 6	P105-4-454-222
	447121 Revision 6	P105-4-454-223
	449317 Revision 3	P105-4-454-215
23	PGandE Drawings Piping Isometrics (Small Bore):	
	H08-386 Revision 2	P105-4-454-225
	H08-223 Revision 5	P105-4-454-287
	H08-228 Revision 5	P105-4-454-289
	H08-230 Revision 3	P105-4-454-290

IDVP Calculation Files

Reference No.	Title	Calc. Rev. No.	RLCA File No.
24	Maximum Stresses due to Internal Design Pressures	0	P105-4-521-178
25	Frequency Calculations	1	P105-4-521-179
26	Spectra Envelope	1	P105-4-521-180
27	Check Sheets for Computer Analyses	0	P105-4-521-181
28	Lug Evaluation	2	P105-4-521-182
29	Maximum Stress Results	0	P105-4-521-184

RLCA Computer Analyses

Reference No.	Title	Computer I.D.	RLCA File No.
30	2" SCH.10-1 Span	K152HU3 3/11/82	P105-4-521-172
31	2" SCH.40-1 Span	K152LH3 3/11/82	P105-4-521-173
32	3" SCH.10-1 Span	K15VEYF 3/12/82	P105-4-521-174
33	3" SCH.40-1 Span	K152HJ3 3/11/82	P105-4-521-175
34	4" SCH.10-1 Span	K1520AN 3/11/82	P105-4-521-176
35	4" SCH.40-1 Span	K152H0R 3/11/82	P105-4-521-177
36	2" SCH.10-L Leg 10'	K15VGY3 3/12/82	P105-4-521-162
37	2" SCH.10-L Leg 100'	K154JDZ 3/13/82	P105-4-521-163
38	2" SCH.40-L Leg 10'	K15VHTZ 3/12/82	P105-4-521-164
39	2" SCH.40-L Leg 100'	K154JCN 3/13/82	P105-4-521-165
40	2" SCH.10-Dir.Change	K15VFAR 3/12/82	P105-4-521-166
41	2" SCH.40-Dir.Change	K15VEJV 3/12/82	P105-4-521-167
42	3" SCH.10-Dir.Change	K1520C7 3/11/82	P105-4-521-168
43	3" SCH.40-Dir.Change	K1520B3 3/11/82	P105-4-521-169
44	4" SCH.10-Dir.Change	K1520HB 3/11/82	P105-4-521-170
45	4" SCH.40-Dir.Change	K1520JF 3/11/82	P105-4-521-171
46	2" SCH.10-3 Spans	K154II3 3/13/82	P105-4-521-156
47	2" SCH.40-3 Spans	K152LB7 3/11/82	P105-4-521-157
48	3" SCH.10-3 Spans	K154I1F 3/13/82	P105-4-521-158
49	3" SCH.40-3 Spans	K154I73 3/13/82	P105-4-521-159
50	4" SCH.10-3 Spans	K152LE7 3/11/82	P105-4-521-160
51	4" SCH.40-3 Spans	K154I4B 3/13/82	P105-4-521-161

Appendix A

Key Word Definitions

(7 pages)

APPENDIX A

KEY TERMS AND DEFINITIONS

(The definitions in this glossary establish the meanings of words in the context of their use in this document. These meanings in no way replace the specfic legal and licensing definitions.

Closed Item

- A form of program resolution of an Open Item which indicates that the reported aspect is neither an Error nor a Deviation. No further IDVP action is required (from Reference 21).

Completion Report

- Used to indicate that the IDVP effort related to the Open Item identified by the File Number is complete. It references either a Program Resolution Report which recategorized the item as a Closed Item or a PGandE document which states that no physical modification is to be applied in the case of a Deviation or a Class C or Class D Error (from Reference 21).

DCNPP-1

- Diablo Canyon Nuclear Power Plant Unit 1.

Design Review Isometrics

- Drawings representing the three dimensional layout of piping systems used for the qualification analyses of the piping system.

EOI

- Error and Open Item Report.

Error Report

- An Error is a form of program resolution of an Open Item indicating an incorrect result that has been verified as such. It may be due to a mathematical mistake, use of wrong analytical method, omission of data or use of inapplicable data.

  Each Error shall be classified as one of the following (from Reference 21):

  - Class A: An Error is considered Class A if design criteria or operating limits of safety related equipment are exceeded and, as a result, physical modifications or changes in operating procedures are required. Any PGandE corrective action is subject to verification by the IDVP.

  - Class B: An Error is considered Class B if design criteria or operating limits of safety related equipment are exceeded, but are resolvable by means of more realistic calculations or retesting. Any PGandE corrective action is subject to verification by the IDVP.

  - Class C: An Error is considered Class C if incorrect engineering or installation of safety related equipment is found, but no design criteria or operating limits are exceeded. No physical modifications are required, but if any are applied they are subject to verification by the IDVP.

  - Class D: An Error is considered Class D if safety related equipment is not affected. No physical modifications are required, but if any are applied, they are subject to verification by the IDVP.

Faulted Condition

- Those operating conditions associated with postulated events of extremely low probability, such as the Hosgri event.

FSAR

- PGandE's Final Safety Analysis Report.

Field Verification

- IDVP process of verifying actual configuration of equipment, buildings and components at the installation site against PGandE drawings.

Hosgri Criteria

- Licensing criteria referring specifically to the postulated 7.5M Hosgri earthquake.

Hosgri Report

- A report issued by PGandE that summarizes their evaluation of the DCNPP-1 for the postulated Hosgri 7.5M earthquake. Includes seismic licensing criteria.

Hosgri 7.5M Earthquake

- Maximum intensity earthquake for which the plant is designed to remain functional. Same as Safe Shutdown Earthquake (SSE).

Independent Analysis

- Seismic analysis performed by Robert L. Cloud and Associates.

Interim Technical Report

- Interim technical reports are prepared when a program participant has completed an aspect of their assigned effort in order to provide the completed analysis and conclusion. These may be in support of an Error, Open Item or Program Resolution Report, in support of a portion of the work which verifies acceptability or in support of other IDVP action. Since such a report is a conclusion of the program, it is subject to the review and approval of the Program Manager. The report will be transmitted simultaneously to PGandE and to NRC (from Reference 16).

Lug

- Welded load bearing attachment to pressure retaining piping.

Normal Condition

- Those operating conditions in the course of system startup, operation, hot standby, refueling, and shutdown other than upset, emergency, or faulted plant conditions.

NRC

- Nuclear Regulatory Commission

NRC Order Suspending License CLI-81-30

- The order dated November 19, 1981 that suspended the license to load fuel and operate DCNPP-1 at power levels up to 5% of full power and specified the programs that must be completed prior to lifting of the suspension.

Open Item

- An Open Item Report is issued for the purpose of reporting an IDVP response to a QA and Design Control deficiency, a violation of the verification criteria, or an apparent inconsistency in the performance of the work. The forms of program resolution of an Open Item are recategorization as an Error, Deviation, or a Closed Item (from Reference 21).

PGandE

- Pacific Gas and Electric Company

Phase I Program

- Review performed by RLCA, RFR, and TES restricted to verifying work performed prior to June 1978 related to the Hosgri re-evaluation design activities of PGandE and their service-related contractors.

PGandE Design Class I

- PGandE engineering classification for structures, systems and components which corresponds to NRC Regulatory Guide 1.29 Seismic Category I classification.

Potential Program Resolution Report and Potential Error Report

- Forms used for communication within IDVP (Reference 21).

Program Resolution Report

- Used to indicate that the specific item is no longer active in the IDVP. It indicates whether the resolution is a Closed Item, a Deviation, or that responsibility for an Open Item has been transferred to the PGandE Technical Program. Further IDVP action is required upon completion of the associated PGandE Technical Program Task if the IDVP transfers an Open Item to PGandE or if physical modifications are applied with respect to a deviation (Reference 21).

Response

- The motion resulting from an excitation of a device or system under specified conditions.

Response Spectra

- Graph showing relationship between acceleration and frequency. Used in seismic analysis.

RLCA

- Robert L. Cloud and Associates, Inc.

RFR

- Roger F. Reedy, Inc.

Rules

- Guidelines and criteria used by PGandE.

Sample

- Initial Sample stipulated in Phase I Program of equipment, components, and buildings to be design verified by independent analysis.

Sampling Approach

- Method used by the IDVP to determine the initial sample (buildings, piping, equipment and components) for analysis and to provide for sample expansion when required.

Schedules

- Measure of pipe wall thickness and pressure rating.

Seismic Spans

- Those pipe spans considered to be dynamically active during earthquake loading.

Span Evaluation

- Spacing specifications used to construct and qualify piping in lieu of dynamic analysis of all configurations.

Span Rules

- Specified distance between pipe supports.

Spectral input

- Acceleration value taken from response spectra for input into seismic analysis.

SWEC

- Stone & Webster Engineering Corporation

TES

- Teledyne Engineering Services

Verification Program

- Undertaken by the IDVP to evaluate Diablo Canyon Nuclear Power Plant for compliance with the licensing criteria.

Appendix B

ADLPIPE Computer Program

(1 page)

APPENDIX B

ADLPIPE Computer Program

The independent analyses of the DCNPP-1 piping samples were accomplished using the computer program ADLPIPE. ADLPIPE has the capability to perform linear elastic analysis of three-dimensional piping systems. In addition, ADLPIPE can perform various ASME and ANSI code evaluations, specifically ANSI B31.1 Power Piping.

Both static and dynamic loads may be input into the ADLPIPE analyses. The static loads may include thermal, deadweight, pressure, and externally applied forces and moments. The dynamic loads include time-history forcing functions and seismic response spectra. Various methods are available for combining the seismic responses.

The ADLPIPE program has been available in different versions since the early 1960's. The version used for the verification analyses is version ID (Release 0 and Release 1). It is also one of the more widely used and accepted piping analysis programs in industry to date. The ADLPIPE program has been compared with the NRC program EPIPE for dynamic analysis of six NRC benchmark problems.

Appendix C

Error and Open Item Reports

(3 pages)

Appendix C

Error and Open Item Reports

(Page 1 of 3)

EOI File No.	Subject	Rev.	Date	By	Type	Action Required	Physical Mod.
1024	Support labeled 85S/40V and 85S/40R	0	2/20/82	RLCA	OIR	RLCA	
		1	5/20/82	RLCA	PPRR/CI	TES	
		2	6/7/82	TES	PRR/CI	TES	
		3	6/7/82	TES	CR	None	No
1043	PGandE isometric 446548 Revision 8 differs from the field condition support analyses	0	3/8/82	RLCA	OIR	RLCA	
		1	3/22/82	RLCA	PPRR/DEV	TES	
		2	4/17/82	TES	PRR/OIP	PGandE	
		3	7/13/82	TES	OIR	RLCA	
		4	7/17/82	RLCA	PPRR/DEV	TES	
		5	7/28/82	RLCA	PRR/DEV	PGandE	
		6	7/28/82	TES	CR	None	No
1044	Supports not noted on design isometric	0	3/8/82	RLCA	OIR	RLCA	
		1	3/22/82	RLCA	PPRR/DEV	TES	
		2	4/17/82	TES	PRR/OIP	PGandE	
		3	7/8/82	TES	OIR	RLCA	
		4	7/17/82	RLCA	PPRR/CI	TES	
		5	8/11/82	TES	PRR/CI	PGandE	
		6	8/11/82	TES	CR	None	No
1045	Support 99/9R Restraint Directions	0	3/8/82	RLCA	OIR	RLCA	
		1	3/22/82	RLCA	PPRR/DEV	TES	
		2	5/10/82	TES	PRR/OIP	PGandE	
		3	7/8/82	TES	OIR	RLCA	
		4	7/17/82	RLCA	PPRR/DEV	TES	
		5	7/28/82	TES	PRR/DEV	PGandE	
		6	7/28/82	TES	CR	None	No

STATUS: Status is indicated by the type of classification of latest report received by PGandE:

- OIR - Open Item Report
- PPRR - Potential Program Resolution Report
- PRR - Program Resolution Report
- PER - Potential Error Report
- OIP - Open Item with future action by PGandE
- ER - Error Report
- CR - Completion Report
- CI - Closed Item
- DEV - Deviation
- A - Class A Error
- B - Class B Error
- C - Class C Error
- D - Class D Error

PHYSICAL MOD: Physical modification required to resolve the issue. Blank entry indicates that modification has not been determined.

EOI File No.	Subject	Rev.	Date	By	Type	Action Required	Physical Mod.
1046	Isometric 446548 Revision 8, dimensional difference	0	3/8/82	RLCA	OIR	RLCA	
		1	3/22/82	RLCA	PPRR/DEV	TES	
		2	4/17/82	TES	PRR/OIP		
		3	7/13/82	TES	OIR	RLCA	
		4	7/17/82	RLCA	PPRR/DEV	TES	
		5	7/28/82	TES	PRR/DEV	PGandE	
		6	7/28/82	TES	CR	None	No
1047	Supports not noted on design isometric	0	3/8/82	RLCA	OIR	RLCA	
		1	3/22/82	RLCA	PPRR/DEV	TES	
		2	5/10/82	TES	PRR/OIP	PGandE	
		3	7/8/82	TES	OIR	RLCA	
		4	9/11/82	RLCA	PPRR/CI	TES	
		5	10/5/82	TES	PRR/CI	PGandE	
		6	10/5/82	TES	CR	None	No
1048	Line 52 - span does not conform to span rules	0	3/8/82	RLCA	OIR	RLCA	
		1	5/10/82	RLCA	PPRR/CI	TES	
		2	6/10/82	TES	PRR/CI	TES	
		3	6/10/82	TES	CR	None	No
1058	Stresses at single lug and certain two lug locations were found to exceed allowables assuming maximum load span.	0	3/15/82	RLCA	OIR	RLCA	
		1	6/18/82	RLCA	PPRR/OIP	TES	
		2	7/13/82	TES	PRR/OIP	PGandE	
		3	9/10/82	TES	OIR	RLCA	
		4	9/13/82	RLCA	PPRR/CI	TES	
		5	9/21/82	TES	PRR/CI	TES	
		6	9/21/82	TES	CR	None	No

STATUS: Status is indicated by the type of classification of latest report received by PGandE:

- OIR - Open Item Report
- PPRR - Potential Program Resolution Report
- PRR - Program Resolution Report
- PER - Potential Error Report
- OIP - Open Item with future action by PGandE
- ER - Error Report
- CR - Completion Report
- CI - Closed Item
- DEV - Deviation
- A - Class A Error
- B - Class B Error
- C - Class C Error
- D - Class D Error

PHYSICAL MOD: Physical modification required to resolve the issue. Blank entry indicates that modification has not been determined.

EOI File No.	Subject	Rev.	Date	By	Type	Action Required	Physical Mod.
1059	The PGandE report shows certain pipe stresses above the allowable. The 1969 preliminary Blume report, as noted in the Hosgri report, does not address span conservatism and the span tables do not address insulation weight.	0 1 2 3 4 5 6	3/15/82 6/7/82 6/21/82 9/10/82 9/13/82 9/21/82 9/21/82	RLCA RLCA TES TES RLCA TES TES	OIR PPRR/OIP PRR/OIP OIR PPRR/CI PRR/CI CR	RLCA TES PGandE RLCA TES TES None	No

STATUS: Status is indicated by the type of classification of latest report received by PGandE:

- OIR - Open Item Report
- PPRR - Potential Program Resolution Report
- PRR - Program Resolution Report
- PER - Potential Error Report
- OIP - Open Item with future action by PGandE
- ER - Error Report
- CR - Completion Report
- CI - Closed Item
- DEV - Deviation
- A - Class A Error
- B - Class B Error
- C - Class C Error
- D - Class D Error

PHYSICAL MOD: Physical modification required to resolve the issue. Blank entry indicates that modification has not been determined.

Appendix D

PGandE Open Items

(4 pages)

Appendix D

PGandE Open Items

Open Item No.	Concern	Resolution	Conclusion of Resolution
4	Review all of Unit 1 small bore piping has identified 42 supports requiring vertical restraint where only a single rod was utilized. Modification of these supports will be made.	All small bore piping single rod supports required to function as vertical restraints will be identified and modified to provide restraint to both upward and downward movement.	Forty-two single rod supports were found in locations which required vertical restraint and these supports have been modified to prevent uplift. This item is closed (820315).
6	Certain small bore piping spans have been identified as deviating from seismic criteria. Review and analysis will be performed to determine extent and significance.	A large sample of small bore piping has been reviewed and overspans identified. Analysis has been completed to identify those spans which may incur seismic stresses exceeding allowables. The percentage of spans in this class relative to the total population is 0.19%. Design instructions to add supports which would eliminate piping overstress were issued. Verification of support qualifications associated with overspans is complete and all supports reviewed were found to comply with the original acceptance criteria.	This item is closed for the specific issue identified (820420). However, the generic issue of small bore piping overspans is addressed in the Internal Technical Program.
9	One case of a pipe support design with fewer pipe lugs than required by design criteria, resulting in local pipe overstress, has been identified. All pipe support designs will be reviewed to identify any deviations.	All welded pipe attachment designs will be reviewed and qualified or redesigned. Included in this review are local pipe stress effects.	

PGandE Open Items

Open Item No.	Concern	Resolution	Conclusion of Resolution
14	A deficiency in the small bore seismic anchor movement design criteria document was found during review & requalification of small bore piping for attached large bore piping revised seismic displacements. The instruction for projection of skewed lines into effective lengths for the appropriate planes resulted in greater span lengths than the true projected length. The instruction will be revised and all small bore piping reviewed and qualified.	The instruction was corrected. Small bore piping attached to dynamically analyzed large bore piping was reviewed and reanalyzed using correct project span lengths	Small bore piping attached to dynamically analyzed large bore piping has been reviewed and analyzed. No modifications were found to be required. This item is closed (820421).
15	Documentation for qualification of certain small bore piping support standard details for bidirectional loading cannot be located. The existing standard details will be requalified.	The standard support details will be qualified and modifications performed, if required. The effects of spectra revisions and insulation weight will be included in the review.	

PGandE Open Items

Open Item No.	Concern	Resolution	Conclusion of Resolution
16	The existing file 44 Hosgri horizontal seismic coefficient for the auxiliary building at elevation 163 ft. is 5 ft. .It should be 8.5. The file 44 horizontal and vertical seismic coefficients will be verified for current spectra.	The file 44 horizontal and vertical seismic coefficients are being verified for consistency with current spectra. Changes will be reviewed for effect on design and modifications performed, if required.	
17	Seismic anchor movement (SAM) effects were not addressed for large bore PG&E design Class I lines that were installed by span criteria and attached to computer analyzed lines These lines will be identified and analyzed for SAM.	All large bore piping will be analyzed by computer and the effect of SAM will be considered.	

PGandE Open Items

Open Item No.	Concern	Resolution	Conclusion of Resolution
29	Pipe support spacing tables for noncomputer analyzed piping do not consider the effect of the pipe insulation, and the table used for piping greater than 4 in. diameter was not reviewed, approved, and controlled as required by the PG&E quality assurance program.	New spacing tables which consider the weight of insulation are prepared and the effect on piping and support design will be determined. Large bore piping will be reanalyzed by computer. Modifications, if required, will be made.	

Appendix E

Program Manager's Assessment

(1 page)