Interim Technical Report

DIABLO CANYON UNIT 1
INDEPENDENT DESIGN VERIFICATION PROGRAM
HVAC DUCT AND SUPPORTS REPORT
ITR # 15 REVISION 0

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Edward Denison 12/10/82
Project Manager/Date
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HVAC Duct and Supports Report

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PROGRAM MANAGER'S PREFACE

DIABLO CANYON NUCLEAR POWER PLANT - UNIT I
INDEPENDENT DESIGN VERIFICATION PROGRAM

INTERIM TECHNICAL REPORT

HVAC DUCTS AND SUPPORTS

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

This report provides the analytical results, recommendations and conclusions of the IDVP with respect to the initial sample for HVAC ducts and supports. All EOI files initiated for the HVAC duct and support sample have been closed or identified as an error.

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

ITR Reviewed and Approved
IDVP Program Manager
Teledyne Engineering Services

R. Wray
R. Wray
Assistant Project Manager

1.0 INTRODUCTION

Purpose and Scope

This Interim Technical Report summarizes the independent analysis and verification of the initial sample of HVAC ducts and duct supports at Diablo Canyon Nuclear Power Plant Unit 1 (DCNPP-1).

The HVAC duct and duct support samples each consist of two sections of duct. Sample No. 1 of duct and associated supports is located in the turbine building elevation 119 feet. It provides ventilation to the 4.16kV switchgear. Sample No. 2 of duct and associated supports is located in the auxiliary building elevation 100 feet. It provides ventilation for the primary make-up water pumps.

This report is one of several Interim Technical Reports of the Independent Design Verification Program (IDVP). Interim Technical Reports (ITR) include references, sample definitions and descriptions, methodology, a listing of Error and Open Items, an examination of trends and concerns, and a conclusion (Reference 1). This report presents the IDVP HVAC duct and duct support analyses, comparison with the design analysis results and serves as a vehicle for NRC review. It will also be referenced in the Phase I final report.

Summary

Robert L. Cloud and Associates (RLCA) performed verification analyses for two samples of HVAC duct and duct supports. Field verified information was used in both hand and computer calculations to evaluate stresses. The results showed the samples of HVAC duct and duct supports to be adequate to withstand the effects of the postulated Hosgri event.

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 (DCNPP-1). This error resulted in an incorrect application of the seismic floor reponse 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 7.5M Hosgri earthquake: This program was presented orally to the NRC in a meeting in Bethesda, Maryland on October 9, 1981.

Robert L. Cloud and Associates (RLCA) presented a preliminary report on the seismic reverification program to the NRC on November 12, 1981 (Reference 2). This report dealt with an examination of the interface between URS/Blume and PGandE. At this time RLCA noted that the Hosgri qualification analysis for an HVAC support could not be located (EOI 1003).

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 ensure 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. The Phase I plan for this program was transmitted to the NRC on December 4, 1981 and discussed with the NRC staff on February 3, 1982. Phase I deals with PGandE internal activities 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 (RLCA). However, RLCA continued to perform the independent review of seismic, structural and mechanical aspects of Phase I.

The NRC approved the Indepedent Design Verification Program Phase I Engineering 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 analyses are to be compared to the design analysis results.

2.0 IDVP DESIGN VERIFICATION METHODS

2.1 METHODOLOGY

The IDVP used the following procedure for the independent verification analyses of the sample HVAC duct and duct supports.

First, the physical dimensions and configuration of the duct and supports were field verified. Next, the duct and supports were mathematically modeled to simulate the mass and stiffness characteristics. Computer models used the STARDYNE computer code and the Lanczos modal extraction method. From these models, the natural frequencies were determined.

Seismic accelerations were computed using these natural frequencies together with Hosgri response spectra selected from the figures listed in Appendix A. Forces and moments were then calculated for the key areas of both the duct and duct supports and used to determine stresses. Stresses were determined from the forces and moments enveloped from two load cases vertical and East-West, and vertical and North-South. These computed stresses were then compared to the allowable stresses. Finally, IDVP results were compared to the results of the design analyses.

2.2 LICENSING CRITERIA

The Diablo Canyon Nuclear Power Plant Unit 1 licensing criteria does not explicitly address HVAC duct and supports (References 3 and 4). Hosgri response spectra (Appendix A) and the two load cases noted above were used in the IDVP analyses.

Standard engineering approaches were employed by the IDVP to calculate loads and stresses. Allowables were obtained from the following sources.

AISC 7th Edition (1st Revision) - General

PGandE Specification 8872 - Anchor Bolts

PGandE Drawing 054162 Revision 3 - Anchor Bolts 3/4 inch diameter

Formulas for Stress and Strain, - Local Panel Buckling Roarke, 5th Edition

3.0 IDVP ANALYSIS OF HVAC DUCT AND SUPPORTS

3.1 DUCT SAMPLE NO. 1

The IDVP duct sample No. 1 consists of one 36 x 16 inch 22 gauge rectangular duct leading from the supply fan S-69 to the 4.16kV switchgear room. The duct sample begins at the floor (elevation 119 feet) and runs vertically past fan S-69 to a 90 degree elbow near the ceiling at elevation 140 feet. The duct then runs horizontally east to the 4.16kV switchgear room. Figure 1 shows this duct run.

The vertical duct is restrained by two intermediate supports. In addition, the duct at the wall and slab penetrations is riveted to built-in flanges.

The horizontal duct is restrained by one three way support and three sets of vertical rod hangers. This horizontal run is covered with 7/8 inch thick pyrocrete (fire protection). In addition, the duct at both wall penetrations is riveted to built-in flanges.

3.1.1 Method of IDVP Analysis

The IDVP developed mathematical models (both closed form and computer) of the duct and supports from field verified dimensions (Reference 15). Since the duct is anchored at the walls and slab, the vertical and horizontal runs were analyzed separately.

Vertical Duct Run

The vertical duct is fixed at the wall mounting near the elbow and at the floor mounting. Thus, the vertical duct is isolated from the horizontal duct (Reference 13 and 14). The field verification showed that angles on three sides of the duct at point 1 (Figure 3), which were shown on the drawing, were not installed (EOI 1110).

The vertical duct was modeled as a simply supported vertical beam with an additional concentrated mass located where the portion of duct tees off to fan S-69 through a flexible coupling. This model was used in the frequency analysis of the vertical duct in the East-West and North-South directions.

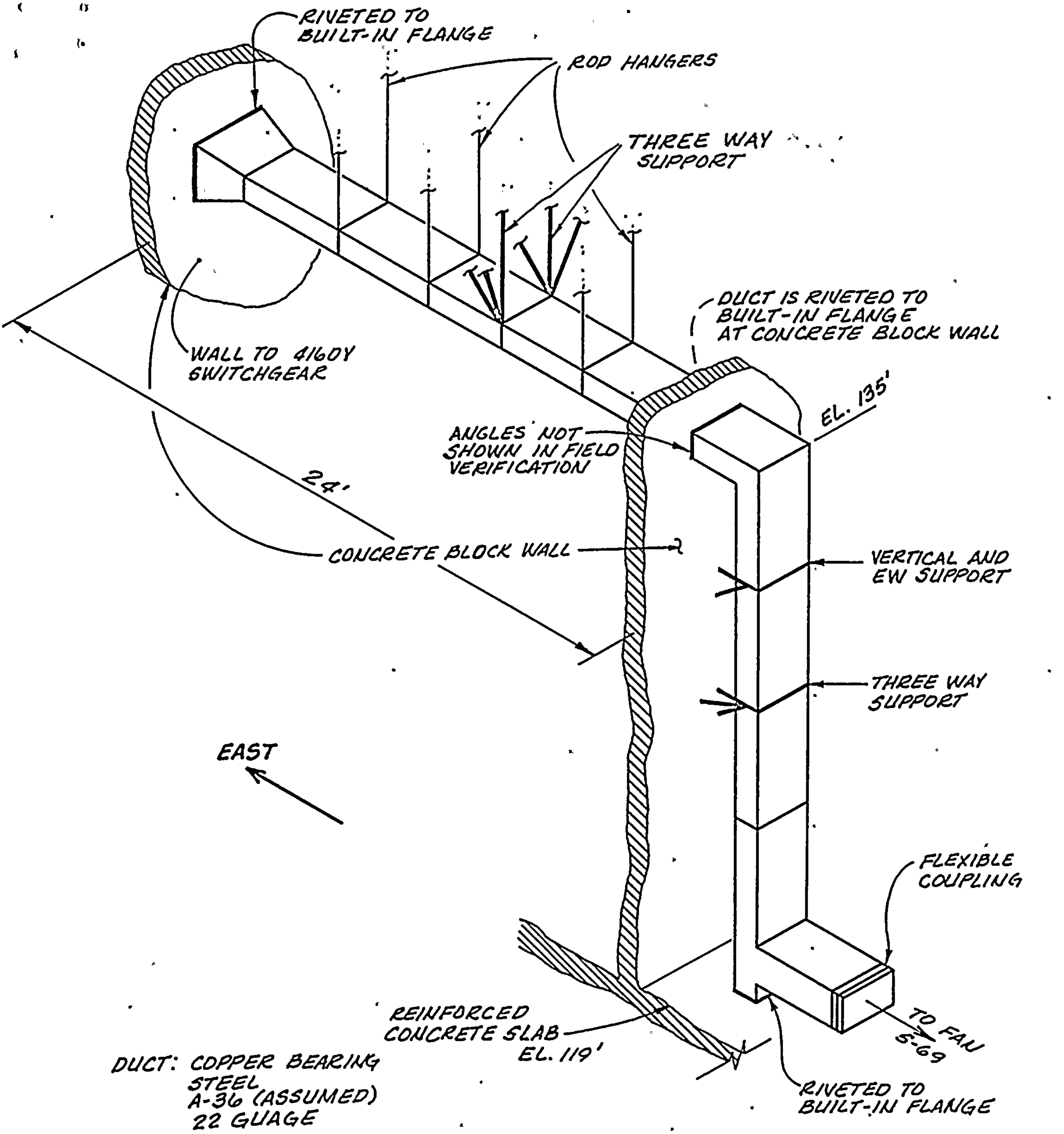
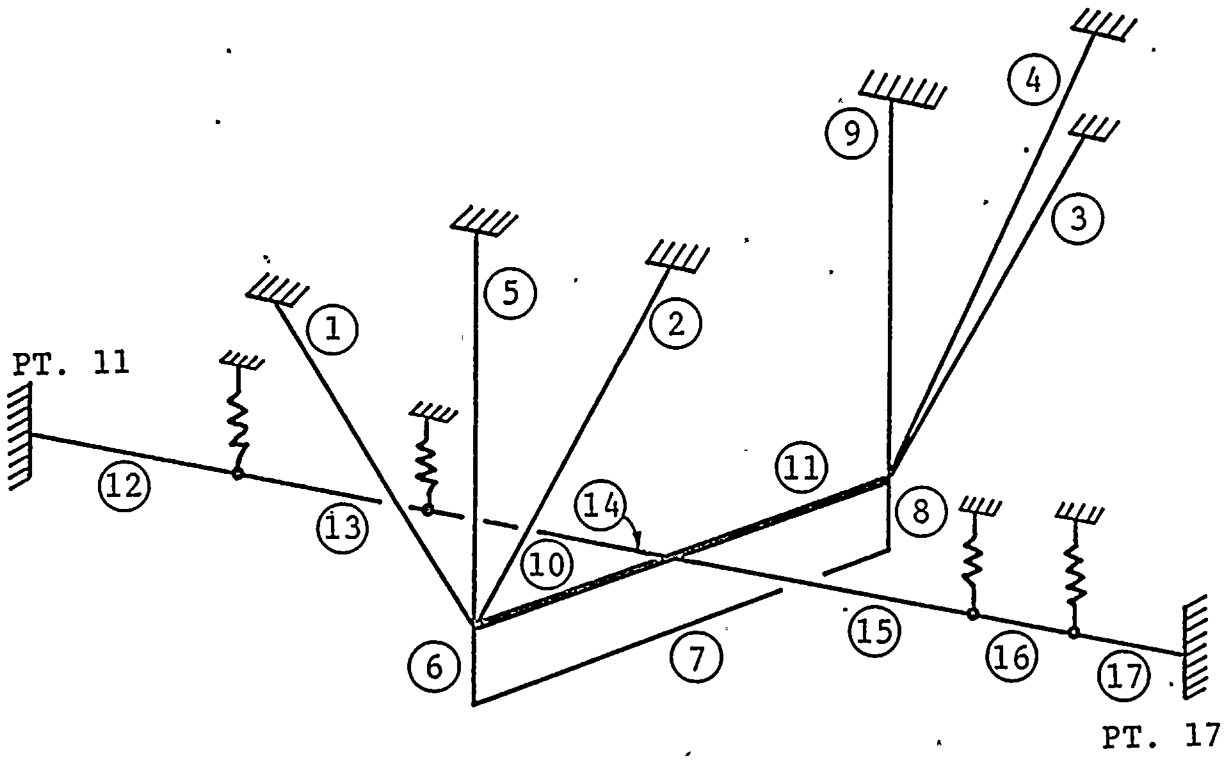


Figure No. 1
Duct Sample No. 1



ELEMENT	LENGTH (inches)	
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2	64.65	
3	64.65	
4	64.65	
5	56.00	
6	8.00	
7	36.00	
8	8.00	
9	56.00	
10	18.00	(Rigid Element)
11	18.00	(Rigid Element)
12	59.00	
13	49.00	
14	24.00	
15	34.00	
16	64.00	
17	58.00	

Figure No. 2
Computer Model Duct Sample No. 1
Horizontal Run

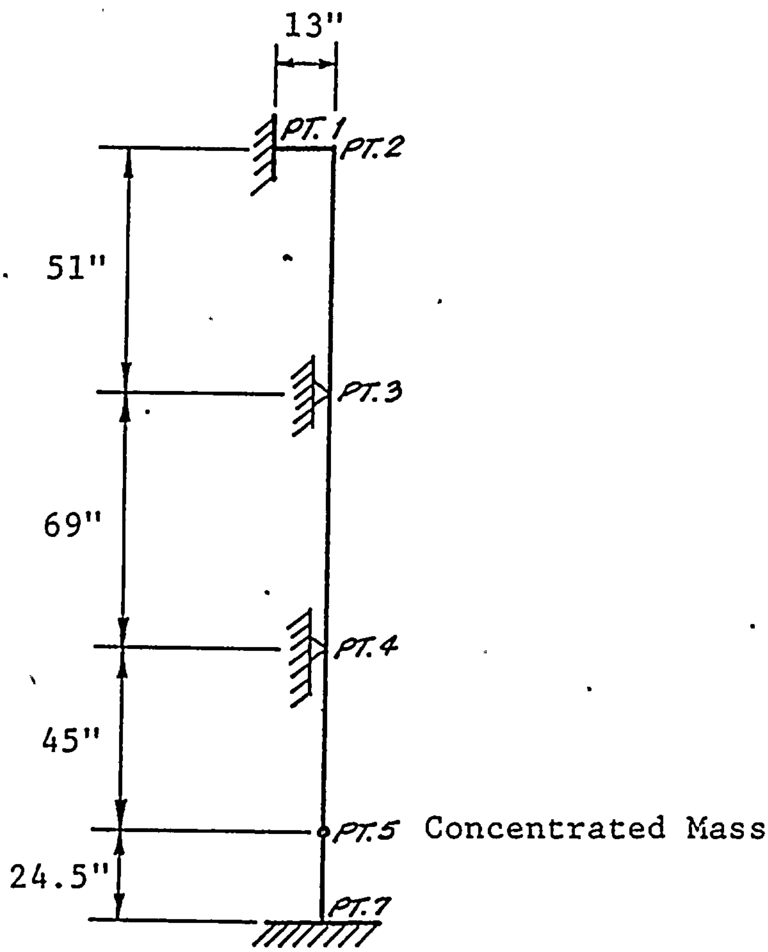


Figure No. 3
Computer Model Duct Sample No. 1
Vertical Run

The two intermediate supports for this vertical duct were neglected in the closed form frequency analysis. The first natural frequency is in the rigid range, therefore this approach is conservative with respect to the resulting accelerations.

Because the duct is essentially a column, it was assumed to be rigid in the vertical direction.

Seismic accelerations were chosen from Hosgri response spectra, to correspond to the IDVP natural frequency results (see Appendix A).

The values are as follows:

1.5g Horizontal East-West
1.5g Horizontal North-South
1.5g Vertical

All natural frequencies were in the rigid range, and therefore, the damping value selected was irrelevant. To obtain the acceleration values, seismic response spectra for both elevations 119 and 140 feet in the turbine building were enveloped.

To calculate internal duct loads, an equivalent static method was used. These loads were then used to calculate stresses in the vertical duct using the closed form solution (simply supported beam with a concentrated mass).

To calculate support loads, a STARDYNE computer model was developed (See Figure 3). Loads at each of the supports were calculated by applying the acceleration values noted above to this duct model. The vertical duct and supports were represented as a series of beam elements. The duct attachment at the floor and at the wall were represented as fixed points. The rivets, spaced 8 inches on center, attach to angles which bolt to both the wall and floor. These connections were considered to be fixed. The intermediate supports on the duct were modeled as a restraint in three directions (for the lower support) and as a restraint in the vertical and East-West directions (for the upper support). Stresses were calculated at key locations in the supports.

Horizontal Duct Run

A computer STARDYNE model was developed to compute the duct system frequencies and seismic loads for the horizontal duct run. The duct was modeled with a series of beam elements running between fixed end points at the walls (see Figure 2).

The duct was connected by two rigid elements to the centerline attachment point of the three-way support. The three-way support, constructed of 3 x 3 x 1/4 inch angles, was modeled in detail using a series of beam elements. The 3/8 inch diameter rod hangers were modeled as vertical springs connected between the ceiling and the duct to account for their stiffness. Pyrocrete fire proofing material (5 psf) was included in the mass properties of the duct (Reference 16).

The STARDYNE computer analysis showed that in all directions the natural frequencies of this duct system were greater than 33 hertz. Seismic accelerations were enveloped from Hosgri response spectra to correspond to IDVP natural frequency results. As with the vertical duct, all natural frequencies are in the rigid range and the damping value is irrelevant. Spectra for elevations 119 and 140 feet were used to determine the acceleration values because the duct system attaches to the elevation 140 feet ceiling slab and the walls below.

The seismic acceleration values used in the analysis of the horizontal duct and supports are as follows:

1.5g Horizontal East-West
1.5g Horizontal North-South
1.5g Vertical

The horizontal duct stresses and support loads were computed with the STARDYNE model. Using these support loads, stresses at the key locations of the support were calculated.

3.1.2 Results of IDVP Analysis

The IDVP computed stresses at the following key areas of the duct and duct supports and compared them to the allowable stresses.

	IDVP Results	Allowable
Duct		
Maximum bending stress	438 psi	24,000 psi
Maximum shear stress	.431 psi	14,400 psi
Duct column buckling stress	209 psi	20,180 psi
Duct local panel buckling stress	70 psi	79 psi
Support (Point 3*)		
Anchor bolts		
pull out	150 lb	1773 lb
shear	68 lb	1273 lb
Rivet to duct, shear	28 lb	552 lb
Angle bending stress	5212 psi	24,000 psi
Weld	6098 psi	14,400 psi
Support (Point 4*)		
Anchor bolts		
pull out	105 lb	1773 lb
shear	61 lb	1273 lb
Rivet to duct, shear	32 lb	552 lb.
Weld	80 psi	14,400 psi
Support (Point 7*)		
Capscrews, pullout	193 lb	1268 lb
Rivet to duct, shear	197 lb	552 lb

* For location designations, see Figure 2

Table 1
Vertical Duct and Duct Supports Results

	IDVP Results	Allowable
Duct		
Maximum bending and axial stress	821 psi	24,000 psi
Maximum shear stress	340 psi	14,400 psi
Bilateral support angles		
Maximum bending stress	1333 psi	24,000 psi
Maximum shear stress	43 psi	14,400 psi
Anchor bolts		
pullout	1066 lb	1773 lb
shear	623 lb	1273 lb
Support (Point 11*)		
Capscrews		
pullout	338 lb	1268 lb
shear	98 lb	476 lb
Rivet to duct, shear	348 lb	552 lb
Rod Hangers		
Tensile stress	1720 psi	21,600 psi
Compressive stress	344 psi	570 psi

* For location designations, see Figure 3

Table 2

Horizontal Duct and Duct Supports Results

The results show that IDVP calculated stresses for the key areas are below the allowable stresses.

3.1.3 Design Analysis Methods

The design analysis considered only the bilateral support for the horizontal duct leading to the 4.16kV switchgear room.

Because the support is located at mid-span of the duct, the design analysis considered the total support mass to be half of the total duct mass added to the support mass structure. This mass along with the calculated stiffness of the support was used to calculate the natural frequency of the support (>33 Hz). Based on these natural frequency results, Hosgri accelerations at elevation 140 feet were selected. These accelerations were used to calculate loads on the support. Using these loads, loads on the concrete expansion anchors were then calculated and compared to the allowables.

3.1.4 Comparison of IDVP and Design Analysis Methods

The design analysis examined the expansion anchor bolts to the bilateral support on the horizontal duct run leading to the 4.16kV switchgear room. For verification purposes, the IDVP performed a more detailed analysis. The IDVP analysis examined the duct stresses, support stresses, and the expansion anchor bolt loads.

In addition, stresses in the built-in flanges at the attachment points in the wall were also examined.

3.1.5 Comparison of IDVP and Design Analysis Results

The IDVP compared their results listed in Section 3.1.2 with results from the design analysis that are shown below:

		IDVP Analysis	Design Analysis
Load at expansion anchor bolts			
	Pullout	1066 lbs	1635 lbs
	Shear	623 lbs	944 lbs

Table 3

Comparison of IDVP and Design Analysis Results for HVAC Duct Sample No. 1

The larger loads calculated in the design analysis reflect the conservatism in the simplified design analysis approach.

3.1.6 EOI Reports Issued

The IDVP issued two EOI reports for the HVAC duct sample No. 1. Appendix B shows the EOI file number, revision, date and status.

EOI 1003 was issued as a result of concerns noted in the RLCA report "Preliminary Report, Seismic Reverification Program - November 12, 1981" (Reference 2). The concern noted that Hosgri duct support qualifications for the 4.16kV switchgear room ventilation system had not been located as of October 28, 1981. When the analyses of record dated prior to October 28, 1981 were located, the IDVP found that these calculations did not qualify the three-way support on the horizontal duct run. The current design reanalysis (Reference 7) specifically qualifies the three-way support on the horizontal duct.

EOI 1003 was combined with 1077 (see Section 3.2.6) and classified as a Class A or B Error because the Diablo Canyon Project has stated that HVAC supports are being reanalyzed (Reference 8).

EOI 1110 was issued as a result of a difference between the field verified condition and the design drawing. The design drawing calls for angles on three sides of the duct at point 1 (Figure 3) for HVAC sample No.1. The IDVP field verification does not show these angles. The IDVP analysis which is based on the field verified conditions did not include the missing angles. This EOI is classified as a potential open item with future action by PGandE.

3.2 HVAC SAMPLE NO. 2

HVAC sample No. 2 consists of both 12 and 10 inch diameter duct segments. Neither of these ducts are covered by fireproofing material.

The 12 inch diameter 24 gauge duct which extends over the primary make-up water pumps at elevation 100 feet is in the auxiliary building. This duct is welded to a built-in flange at one end and restrained by one bilateral support (vertical and North-South). Figures 4 and 5 show this duct.

The straight 10 inch diameter, 24 gauge, duct is also in the auxiliary building at elevation 100 feet just south of the HEPA filter rooms and the roughing filter room. This duct is welded to built-in flanges at each of the ends and is restrained by three sets of 3/8 inch rod hangers. Figure 6 shows this duct.

3.2.1 Method of IDVP Analysis

The IDVP developed STARDYNE computer models of the 12 and 10 inch diameter ducts and supports using field verified information (Reference 15). These computer models are shown in Figures 7 and 8.

12 Inch Diameter Duct

The 12 inch diameter duct and bilateral support was modeled as a series of beam elements, assuming a fixed end at the wall. This model included two rigid links (elements 22 and 23) which connected the duct to the support.

All the bilateral support members were represented in the model. The rigid element connection was modeled as a three-way support. This yielded conservative loads on the bilateral support. The resultant frequencies were greater than 39 Hertz. The IDVP determined that this additional direction of restraint was not significant in the frequency calculation.

Accelerations were obtained from the elevation 115 feet Hosgri spectra (Appendix A) as shown below.

1.23g Horizontal East-West
1.05g Horizontal North-South
.80g Vertical

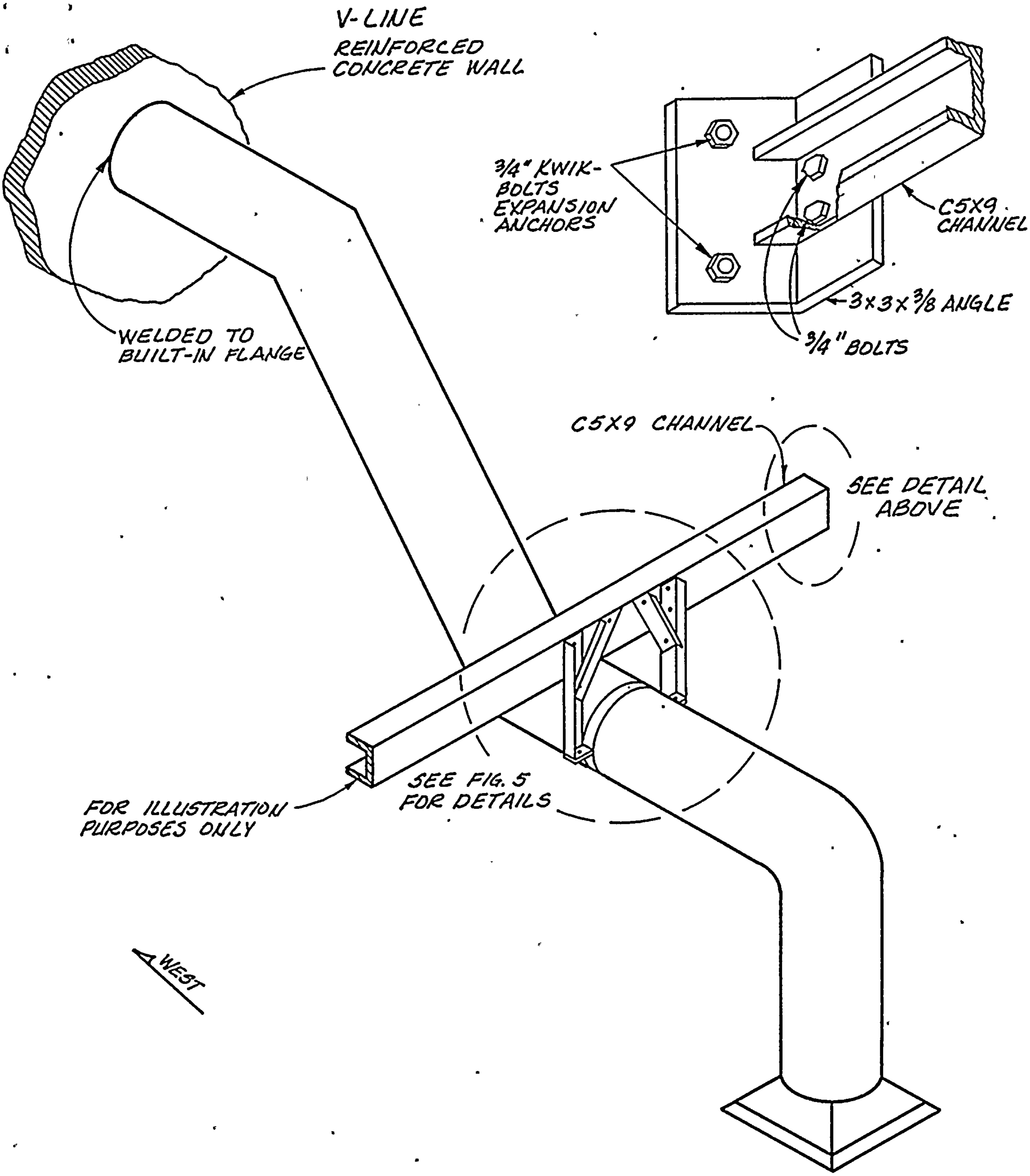


Figure No. 4
Duct Sample No. 2
12 Inch Duct

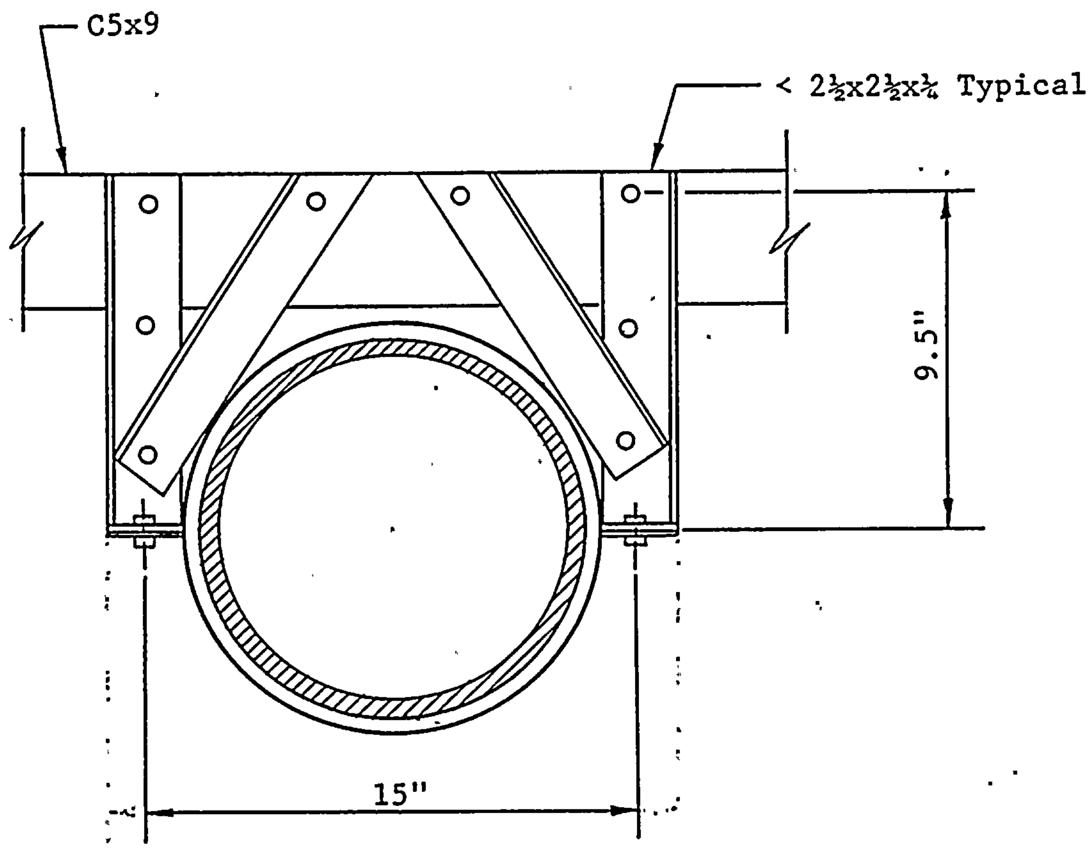


Figure No. 5
Duct Sample No. 2
12 Inch Duct, Support Detail

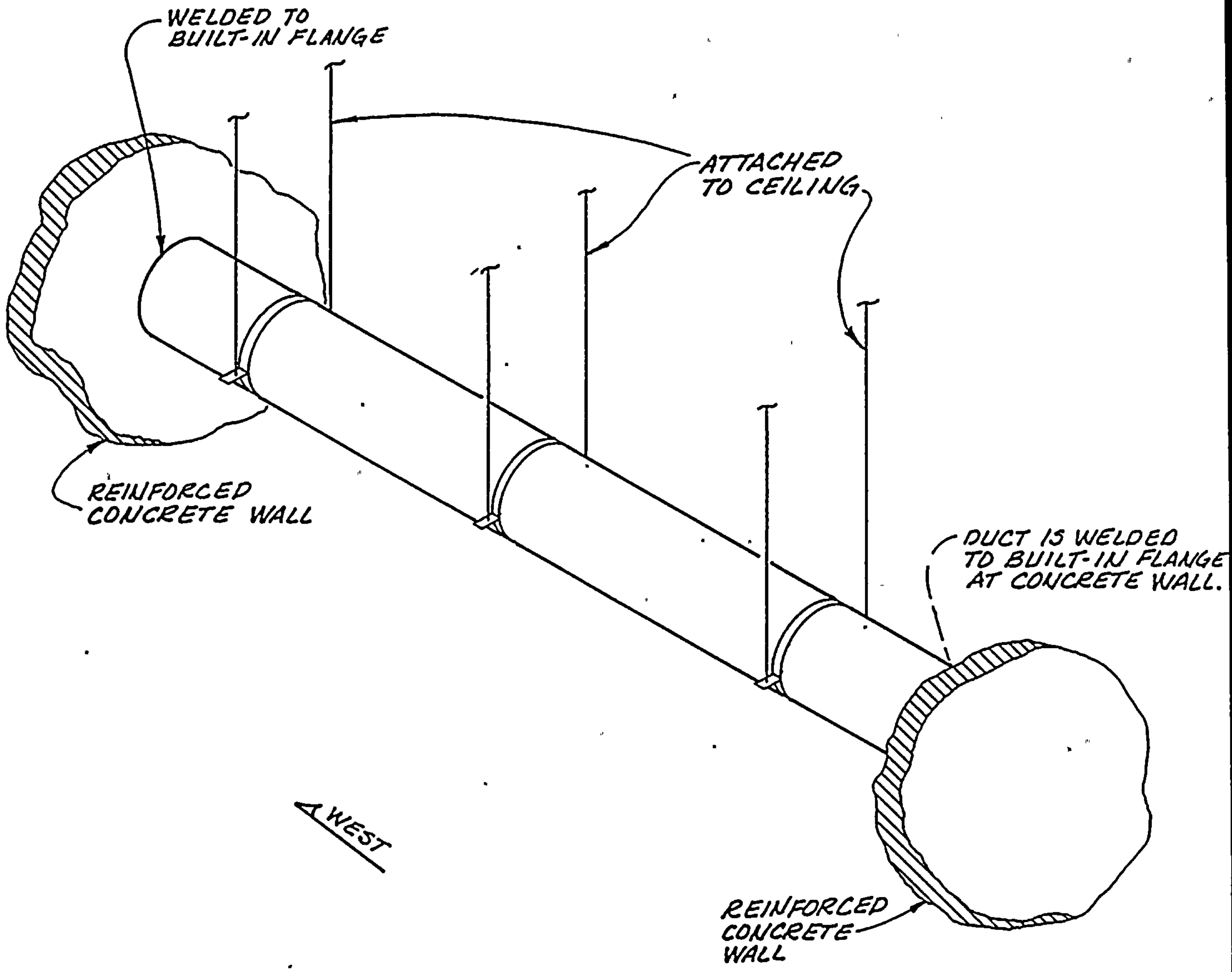
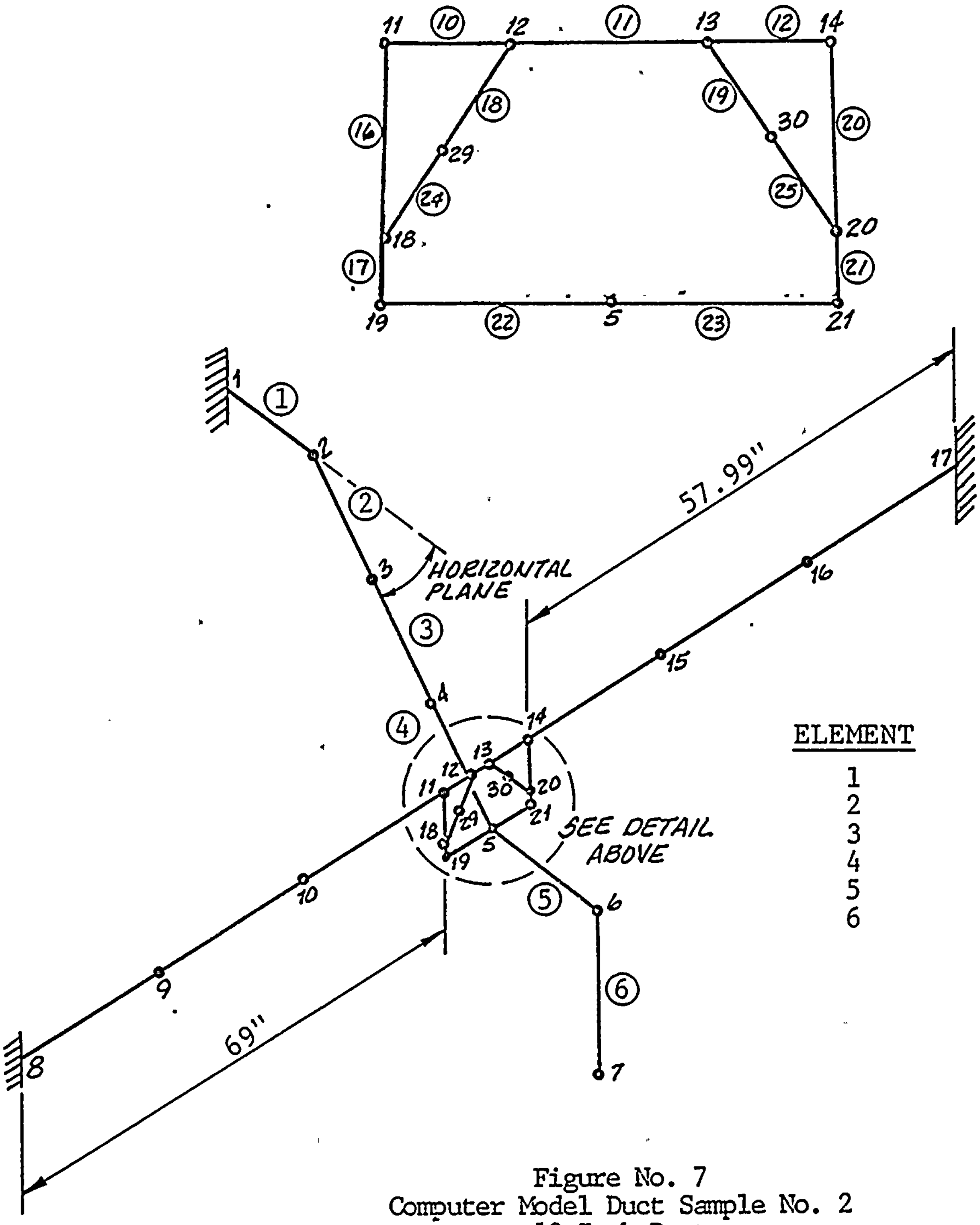


Figure No. 6
Duct Sample No. 2
10 Inch Duct



ELEMENT	LENGTH (inches
1	10.00
2	16.72
3	16.72
4	16.72
5	18.00
6	30.00

Figure No. 7
Computer Model Duct Sample No. 2
12 Inch Duct

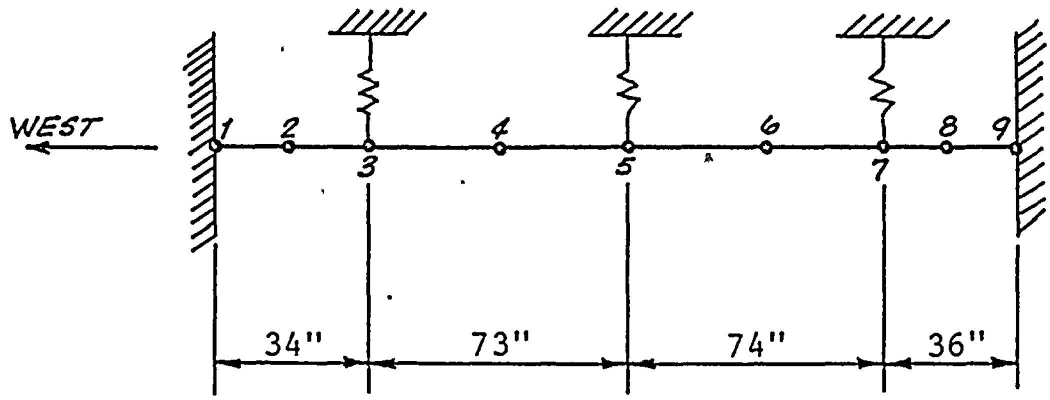


Figure No. 8
Computer Model Duct Sample No. 2
10 Inch Duct

Since all frequencies were found to be in the rigid range, the damping value used was irrelevant.

These accelerations were used to calculate duct stresses and support loads using the STARDYNE computer model. Support stresses were then hand calculated from these loads.

10 Inch Diameter Duct

The straight run of 10 inch diameter duct was modeled as a series of beam elements assuming fixed-end connections at the walls. This model is shown in Figure 8. Rod hanger supports were modeled as springs to account for stiffness.

Accelerations were obtained from the elevation 115 feet Hosgri spectra (Appendix A) as shown below:

1.20g Horizontal East-West
1.16g Horizontal North-South
0.60g Vertical

Since all frequencies were found to be in the rigid range the damping value used was irrelevant. These accelerations were used along with the computer model to calculate duct stresses and support loads. Support stresses were then hand calculated from these loads.

3.2.2 Results of IDVP Analysis

The IDVP compared the calculated stresses for HVAC duct sample No. 2 to the allowable stresses. These comparisons are presented in Tables 4 and 5.

	IDVP Analysis Results	Allowable
Duct		
Maximum bending and axial stress	1063 psi	24,000 psi
Maximum shear stress	258 psi	14,400 psi
Support		
C5x9 Channel		
Maximum bending stress (at node 9)	1111 psi	24,000 psi
Maximum shear stress (at node 12)	1470 psi	14,400 psi
2-1/2 x 2-1/2 x 1/4 inch Angle		
Maximum bending stress (at node 21)	1617 psi	24,000 psi
Maximum shear stress (at node 11)	558 psi	14,400 psi
Point 1*		
Weld maximum shear stress	1495 psi	14,400 psi
Point 8*		
Bolt shear	937 lb	3,340 lb
Channel bearing	937 lb	11,400 lb
Angle		
Bearing	937 lb	13,700 lb
Shear tearout stress	832 psi	14,400 psi
Anchor bolt (combined pullout and shear interaction)	0.21	1.0
Angle (at wall)		
Bearing	52 lb	13,700 lb
Shear tearout stress	45 psi	14,400 psi

* For location designations, see Figure 7

Table 4

12 Inch Duct Results

	IDVP Results	Allowable
Point 17		
Bolt shear	970 lb	3,340 lb
Channel bearing	970 lb	11,400 lb
Angle		
Bearing	970 lb	13,700 lb
Shear tearout stress	862 psi	14,400 psi
Anchor bolt	0.23	1.0
(combined pullout and shear interaction)		
Angle (at wall)		
Bearing	65 lb	9,110 lb
Shear tearout stress	48 psi	14,400 psi
Points 12,13,18,20		
(Worst case reported)		
Bolt		
Tensile	115 lb	6,680 lb
Shear	111 lb	3,340 lb
Angle		
Bearing	111 lb	9,110 lb
Shear tearout stress	170 psi	14,400 psi
Points 11,14		
(worst case reported)		
Bolt		
Tensile	30 lb	6,680 lb
Shear	78 lb	3,340 lb
Angle		
Bearing	78 lb	9,110 lb.
Shear tearout stress	120 psi	14,400 psi
Points 19,21		
(worst case reported)		
Bolt		
Tensile	600 lb	6,680 lb
Shear	116 lb	3,340 lb
Plate		
Bearing	116 lb	9,110 lb
Shear tearout stress	198 lb	14,400 lb
Weld shear stress	9,797 psi	14,400 psi
Duct strap		
Maximum tensile stress	4859 psi	24,000 psi

Table 4
12 Inch Duct Results (cont.)

	IDVP Results	Allowable
<u>Duct</u>		
Maximum bending stress	572 psi	24,000 psi
Maximum shear stress	70 psi	14,400 psi
<u>Support Points 1 and 9*</u> (worst case reported)		
Weld shear stress	839 psi	14,400 psi
<u>Rod Hanger</u> (worst case reported)		
Tensile stress	143 psi	21,600 psi
<u>Duct Strap</u>		
Maximum bending stress	9,700 psi	24,000 psi
Maximum shear stress	202 psi	14,400 psi

Table 5

10 Inch Duct Results

*For location designations see Figure 8

3.2.3 Design Analysis Methods

Following the IDVP sample selection, a design analysis was performed (Reference 9) which considered the bilateral support for the 12 inch diameter duct over the primary make-up water pumps. A Hosgri qualification analysis for the bilateral support dated prior to the selection of this HVAC sample could not be provided (EOI 1077). The natural frequency of the support in the vertical direction was calculated by hand. Seismic loads on the support were analyzed in both the vertical and horizontal directions. The design analysis examined only the stresses in the support channel.

The 10 inch diameter duct is supported by rod hangers and built-in flanges. Design analyses were only performed for multidirectional seismic supports, not for rod hangers and built-in flanges.

3.2.4 Comparison of IDVP and Design Analysis Methods

Different methods were used in the IDVP and design analysis to calculate the natural frequencies. The design analysis used hand calculations, while the IDVP analysis used a computer model to derive natural frequencies and to calculate loads and forces at the key locations. The design analysis considered only support stresses while the IDVP analysis examined both the duct and the supports. The IDVP analysis examined the supports in detail, and in particular calculated stresses considering local effects.

The stresses calculated in the design analysis for the support channel are much higher than those determined in the IDVP analysis because the design analysis used a simplified and conservative approach.

3.2.5 Comparison of IDVP and Design Analysis Results

The IDVP compared their results listed in Section 3.2.2 with results from the design analysis as shown below:

	IDVP Analysis	Design Analysis
C5X9 channel bending tensile stress	1.11 ksi	16.9 ksi

12 Inch Duct Comparison

Table 6

The higher stresses calculated in the design analysis reflect the conservatism in the simplified design analysis approach. Total duct and support weight was considered in the design analysis to act at the midspan of a simply supported channel. By contrast, the verification analysis considered portions of duct and support weight to act at the built-in flanges and distributed the channel weight over a partially fixed end beam.

3.2.6 EOI Reports Issued

The IDVP issued one EOI report for HVAC sample No. 2. Appendix B shows the EOI number, revision, date, and status.

EOI 1077 was issued because the Hosgri qualification calculation for the duct support for duct sample No. 2 is dated November 8, 1981. A calculation dated prior to November 8, 1981 (Hosgri re-evaluation) could not be located. Therefore a concern was raised as to whether this duct support was reviewed for the Hosgri.

EOI 1077 was combined with EOI 1003 as an Class A or B Error.

4.0 EVALUATION

4.1 INTERPRETATION

The IDVP performed analyses for two samples of design Class I HVAC duct and supports. The results were compared to the allowables and design results. All stresses were found to be below the allowables.

Three EOIs have been issued as a result of the comparison of IDVP and design analysis results (1003, 1077 and 1110). The IDVP notes a concern based on EOIs 1003 and 1077 that certain HVAC supports may not have been evaluated for Hosgri loadings. EOI 1110 notes a difference between the drawings and as-built conditions and has yet to be resolved.

The design analyses are based on the use of span rules. The IDVP used closed form solutions and computer models to analyze the HVAC samples. This approach was taken in the absence of a documented HVAC duct and support design methodology. However, the IDVP accepts the use of documented span rules for the design and analysis of HVAC duct and supports.

4.2 RECOMMENDATIONS

The following recommendations address the concerns described above.

- o Establish and implement a program to verify that all design Class I HVAC duct and supports are evaluated for Hosgri loadings.
- o Document a design methodology to evaluate design Class I HVAC duct and supports.

The DCP has established an Internal Technical Program to address these concerns for the design Class I HVAC duct and supports. For each of the recommendations, the IDVP will selectively verify the corrective action PGandE implements.

5.0 CONCLUSION

The IDVP performed verification analyses for two samples of HVAC duct and supports. All stresses were found to be below the allowables. As a result of the comparison with the design analyses, two concerns have been noted.

- o In certain cases, design Class I HVAC duct supports were not evaluated for Hosgri loadings
- o A design methodology for evaluation of HVAC ducts and supports has not been documented.

The DCP has initiated corrective actions to address these two concerns. These actions will be reviewed by the IDVP.

6.0 REFERENCES

1. DCNPP Independent Design Verification Program, Program Management Plan, Phase I, Revision 1, July 6, 1982 (Revision 0, March 29, 1982).

2. Preliminary Report, Seismic Reverification Program, Robert L. Cloud Associates, November 12, 1981.

3. Diablo Canyon Site Units 1 and 2 "Final Safety Analysis Report," USAEC Docket Nos. 50-275 and 50-323. RLCA File No. P 105-4-200-005.

4. Seismic Evaluation for Postulated 7.5 M Hosgri Earthquake, USNRC Docket Nos. 50-275 and 50-323. RLCA File No. P105-4-200-001.

5. DCNPP Independent Design Verification Program, Program Procedure, Phase I Engineering Program Plan, Revision 0, March 31, 1982. RLCA File No. P105-4-810-021.

6. PGandE Spec. No. 8827, Specification for Furnishing and Installing of Design Class I Heating and Ventilation Systems for Unit 1 - Diablo Canyon Site. RLCA File No. P105-4-436-002.

7. EOI 1003 resolution material, PGandE Design Analysis. RLCA File No. P105-4-1003-008.

8. PGandE Phase I Final Report, September 17, 1982.

9. PGandE calculations, supplied for RLCA Request for Information No. 88. RLCA File No. P105-4-436-007.

10. URS/ J.A. Blume Report, Turbine Building Evaluation and Structural Modifications for the 7.5 M Hosgri Earthquake, March 1980. RLCA File No. P105-4-441-032.

11. RLCA HVAC Rectangular Duct Analysis, Revsion 2. RLCA File No. P105-4-560-001.

12. RLCA HVAC Round Duct Analysis, Revision 2. RLCA File No. P105-4-560-006.

13. PGandE Drawing "Ventilation Plans and Sections Area A, Elevation 75'3" through 119'0"", 59322, Revision 17.

14. PGandE Drawing "Ventilation Details Areas A,B,C,D and E, Elevtion 85'0" through 140'0"".

15. RLCA Field Verification Records, P105-4-591.5 - 103, 127, 146, 147 and 154.

16. Pyrocrete Information, RLCA File No. P105-4-436-010.

17. DCNPP-IDVP-PP-003 Preparation of Open Item Reports, Program Resolution Reports and IDVP Completion Reports, Revision 1, June 18, 1982.

Appendix A

Hosgri Response Spectra Considered

in the IDVP Analyses

(one page)

Appendix A

Hosgri Response Spectra Figures Considered in the IDVP Analysis

Duct Sample No. 1 (Turbine Building)

Figures (figures from Reference 4 except as noted)

4-205	4-214	4-228
4-206	4-219	29*
4-208	58*	36*
4-209		
45*		

*Figures from Reference 10

Duct Sample No. 2 (Auxiliary Building)

Figures (from Reference 4)

4-113	4-131	4-149
4-114	4-132	4-150
4-118	4-136	
4-119	4-137	
4-122	4-140	
4-123	4-141	
4-126	4-144	
4-127	4-145	

Appendix B

EOI Table

(one page)

Table
Error and Open Item Report

EOI. File No.	Subject	Rev.	Date	By	Type	Action Required	Physical Mod.
1003	Qualification Analysis Not Located	0	2/6/82	RLCA	OIR	RLCA	
		1	6/7/82	RLCA	PPRR/OIP	RLCA	
		2	6/21/82	TES	PRR/OIP	PGandE	
		3	8/23/82	TES	OIR	RLCA	
		4	8/25/82	RLCA	PER/C	TES	
		5	10/5/82	TES	ER/AorB	PGandE	
1077	Qualification Analysis Dated 11/8/81	0	4/6/82	RLCA	OIR	PGandE	
		1	6/7/82	RLCA	PPRR/OIP	OIP	
		2	6/19/82	TES	OIR	RLCA	
		3	6/22/82	RLCA	PPRR/OIP	OIP	
		4	8/11/82	TES	PRR/OIP	OIP	
		5	10/5/82	TES	OIR	RLCA	
		6	10/6/82	RLCA	PPRR/CI	TES	
		7	10/22/82	TES	PRR/CI	TES	
		8	10/22/82	TES	CR	None	
1110	HVAC Duct - Field Verification Difference	0	12/8/82	RLCA	OIR	RLCA	
		1	12/8/82	RLCA	PPRR/OIP	TES	

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.

Robert L. Cloud and Associates, Inc.

RLCA

Appendix C

Key Word Definitions

(six pages)

APPENDIX C

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 specific 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 17).

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 17).

DCNPP-1

- Diablo Canyon Nuclear Power Plant Unit 1.

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:

- o 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.

- o 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.

- o 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.

- o 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 (From Reference 17).

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

Internal Technical Program

- Combined Pacific Gas and Electric Company and Bechtel Power Corporation project formed for Diablo Canyon completion.

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 17).

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 10).

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 17).

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.

RFR

- Roger F. Reedy, Inc.

RLCA

- Robert L. Cloud and Associates, Inc.

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.

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 D

Program Manager's Assessment

(one page)

APPENDIX D

PROGRAM MANAGERS ASSESSMENT

As IDVP Program Manager, TELEDYNE ENGINEERING SERVICES (TES) has established a Review and Evaluation Team, headed by a qualified team leader, as described in Section 7.4(c) of the Phase I Program Management Plan (Rev. I). The assigned team leader for the area, HVAC Ducts and Supports, included in this interim Technical Report, has personally discussed the procedures, approach, field trip files, analyses, calculations, etc. with RLCA personnel. In addition, the TES Team Leader has reviewed the Open Item Files pertaining to this area of responsibility and, in particular, those files for which RLCA has issued Potential Program Resolution Reports or Potential Error Reports, and on the basis of this evaluation, has recommended appropriate resolutions to the IDVP Program Manager.

Based on this review and evaluation process to date, the Team Leader, along with the TES Program Management Team, has studied and has concurred with the Interpretation and Recommendations outlined in Section 4.0 of this report.