Robert L. Cloud and Associates, Inc.

RLCA

Interim Technical Report

DIABLO CANYON UNIT 1
IDVP VERIFICATION OF CORRECTIVE ACTION

HVAC Ducts, Electrical Raceways,
Instrument Tubing and
Associated Supports

ITR #63, Revision 0

Docket No. 50-275
License No. DPR-76

Project Engineer/Date 8/22/83
Technical Review

Project Manager/Date 8/22/83
Approved P 105-4-839-063

PROGRAM MANAGER'S PREFACE

DIABLO CANYON NUCLEAR POWER PLANT - UNIT 1
INDEPENDENT DESIGN VERIFICATION PROGRAM

INTERIM TECHNICAL REPORT

IDVP VERIFICATION OF CORRECTIVE ACTION
HVAC DUCTS, ELECTRICAL RACEWAYS,
INSTRUMENT TUBING AND ASSOCIATED SUPPORTS

This Interim Technical Report, ITR-63, is one of a series of ITRs prepared by the DCNPP-IDVP for the purpose of providing a conclusion to the program.

This report summarizes the IDVP verification of the DCP corrective action for HVAC ducts, electrical raceways, instrument tubing and associated supports. This effort consisted of an independent IDVP design review of a selected sample of each of the above categories of commodities which were analyzed by the Diablo Canyon Project as part of their Corrective Action Program.

The results of the IDVP design reviews have been finalized and reported, herein, for the major portion of the selected samples. Those few not finalized will be reported in Revision 1 of this ITR. The IDVP verification results in this ITR will be reported in Section 4.6.6. and 4.6.8 of the IDVP Final Report.

As IDVP Program Manager, Teledyne Engineering Services has reviewed and approved this Interim Technical Report as well as the verification process, results, and conclusions reported therein. The methodology followed by TES in performing this review and evaluation is described in Appendix D of this report.

ITR Reviewed and Approved
IDVP Program Manager
Teledyne Engineering Services

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IDVP Verification of Corrective Action

HVAC Ducts, Electrical Raceways, Instrument Tubing and Associated Supports

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1.0 INTRODUCTION

Purpose and Scope

This interim technical report summarizes the Independent Design Verification Program (IDVP) review of Diablo Canyon Project (DCP) corrective action performed at the Diablo Canyon Nuclear Power Plant, Unit 1 (DCNPP-1), for:

HVAC ducts and supports
Electrical raceways and supports
Instrument tubing and supports.

The IDVP verification described in this interim technical report (ITR) covers the HVAC ducts, electrical raceways, instrument tubing and associated supports reviewed by the IDVP which are designated as Design Class 1.

The Corrective Action Program (CAP) is defined in the PGandE Phase I Final Report, as a "...broad review..." which "...envelopes the various findings of the previous IDVP and ITP reviews, and provides proper corrective action to all open items found by the previous reviews..." The program was intended to "...provide more complete and consistent documentation of the design work, with all new work performed..." (Reference 1, p. 1.5.2-2).

The IDVP review of this work is defined in ITR #8, Verification Program for PGandE Corrective Action, regarding Hosgri aspects and ITR #35, Verification Plan for Diablo Canyon Project Activities, regarding non-Hosgri aspects (References 2 and 3). In summary, the IDVP review consists of verifying the scope and methodology of the DCP work plan, and the adequacy and completeness of DCP analyses and corrective actions according to the planned scope. In addition, the IDVP field verified as-built conditions.

This report is one of several interim technical reports of the IDVP. Interim technical reports include references, sample definitions and descriptions, methodology, a listing of Error and Open Item Reports, concerns and a conclusion (Reference 4). This document will be referenced in the IDVP Phase I Final Report (Reference 5) and serves as a vehicle for NRC review.

Summary

This report describes the IDVP verification of the Design Class I HVAC ducts, electrical raceways, instrument tubing and associated supports addressed by the DCP as part of their Corrective Action Program.

IDVP verification is complete in the area of instrument tubing and supports. A majority of the IDVP verification is completed in the areas of HVAC ducts and supports and electrical raceways and supports. Revision 1 of this report will contain the complete results of the last design reviews, field verification and completion sample. This completion sample will confirm final design inputs, interface data and the use of design criteria, but will not include a detailed analysis review.

Results, EOI Reports and partial conclusions based on the work completed to date are presented in the individual sections of this report. Verification completed to date has found the DCP work to be generally complete and in compliance with the licensing criteria.

2.0 DCP CORRECTIVE ACTION PROGRAM

The PGandE Phase I Final Report presents the DCP plan and procedures for qualifying HVAC ducts, electrical raceways, instrument tubing and associated supports. The DCP Corrective Action Program (CAP) for HVAC ducts and supports is described in Section 2.5; electrical raceways and supports in Section 2.4; and instrument tubing and supports in Section 2.6.

2.1 HVAC DUCTS AND SUPPORTS

2.1.1 Description

Design Class 1 HVAC ducts and supports were installed using generic design details contained in PGandE drawings and design specifications (References 6 and 7).

Ducts

The ducts are made from light gage galvanized steel. Depending on the duct dimensions, round ducts are made from 16 to 26 gage sheet steel (see Table 1). Rectangular ducts are made from sheet steel ranging in thickness from 18 to 24 gage (see Table 2). Round ducts over 37 inches in diameter are stiffened with rolled angle sections placed circumferentially at intervals along the duct. The size of the stiffeners and the intervals at which they are placed are shown in Table 3. Rectangular ducts with a larger side dimension of 13 inches or more are also stiffened. The size of stiffeners and spacing intervals are shown in Table 4.

Duct Supports

Duct supports are constructed from steel angle members. The members are bolted and/or welded together and connected to the ducts with bolts, rivets or screws. The majority of seismic duct supports are attached to ceilings or walls with 1/2 inch to 3/4 inch concrete expansion anchors (Reference 6).

In the CAP, the duct supports analyzed were those designed specifically for seismic loading. Rod hangers and other deadweight supports were assumed not effective for seismic loadings.

2.1.2 Scope of DCP Review

The DCP initially reviewed seismic analyses of all Design Class 1 HVAC ducts and supports to determine compliance with the seismic design criteria. As a result of this DCP initial review, the DCP implemented a program to analyze all ducts and supports. Field walkdowns were performed to assure that as-built configurations were incorporated into the analyses. As part of the analyses, the DCP considered any revisions to the seismic response spectra.

2.1.3 Methods for Qualification

The DCP methods for qualification are described in the PGandE Phase I Final Report, Section 2.5. The specific details are contained in Design Criteria Memorandum (DCM) C-31, Revision 0 (Reference 9). A detailed algorithm for performing the analyses is given in DCP HVAC Calculation No. HV-4 (Reference 10).

Generic Qualification

The DCP analysis was performed on a generic basis. Similar supports were grouped so that the analysis of the worst case support was sufficient to provide generic conclusions for all supports in the group. To provide qualification for the ducts, the duct associated with a group of supports was analyzed.

Specific Qualification

Specific ducts and supports which could not be qualified on a generic basis were analyzed on a case by case basis. The procedures and criteria for qualification of a specific support and associated duct are the same as those for the generic qualification but were based on specific rather than envelope as-built duct/support size, span, weights, member sizes, pressure and plant location.

2.1.4 Criteria for Qualification

Design qualification criteria are presented in the PGandE Phase I Final Report, Section 2.5 and Design Criteria Memorandum (DCM) C-31, Revision 0.

Seismic Loading

The floor response spectra used for the review and analysis of HVAC ducts and supports were the DDE and Hosgri spectra contained in the Design Criteria Memoranda (DCM) C-17 and C-30 (References 11 and 12).

For generic calculations, worst case (envelope) spectra, for all areas where the support type exists, were used. For supports evaluated for the specific as-built condition, the applicable directional horizontal acceleration was used. The duct and support(s) frequency was calculated on the basis of a coupled duct/support(s) system. This frequency was used to determine the seismic acceleration from the appropriate response spectra. The damping values used were 2% for DDE and 7% for Hosgri.

The horizontal acceleration was calculated separately for East-West and North-South directions. These included their respective torsional contributions.

The higher of the two horizontal accelerations was used to calculate the response of the duct or support. This response was then combined with the response due to vertical seismic acceleration by absolute sum (ABS). Alternatively, the total response was calculated by combining the response due to each of the two horizontal accelerations and the vertical acceleration on a SRSS basis.

Load Combinations

Load combinations for ducts included deadweight, seismic and pressure loads. Pressure loads were taken as the maximum negative operating pressure for a given HVAC system. Duct supports were analyzed for combined deadweight and seismic loads.

Load cases included transverse horizontal plus vertical and longitudinal plus vertical.

Allowable Load and Stresses

Allowable load and stress criteria for the ducts and supports are documented in DCM C-31 (Reference 9).

Duct sheet steel allowable stresses for faulted conditions were taken as 1.6 times the working level In addition shear stress shall not exceed 0.58 Fy. allowables as defined in the AISI code (Reference 13). In addition, sher stress shall not exceed 0.58 Fy. When axial and bending stresses occurred simultaneously, the following interaction equation was to be satisfied.

$$\frac{f_a}{F_b} + \frac{f_b}{F_b} \leq 1.0$$

Where:

f_a and f_b are the calculated axial and flexural stresses and

F_a and F_b are the allowable axial and flexural stresses.

For duct supports (structural steel), the criteria from the AISC code (Reference 14) were used. Provisions for increasing working level stresses for faulted conditions, the interaction of axial and bending stress, and the limit for shear stress are identical to those for the duct sheet steel.

The AISC code was also applied to structural bolts and welds. Provision for increasing defined allowable loads for faulted conditions and for addressing tension and shear interaction are documented in DCM C-31. Ducts and supports which did not meet the acceptance criteria were modified.

2.2 ELECTRICAL RACEWAYS AND SUPPORTS

2.2.1 Description

Electrical raceways consist of cable trays and conduits. Cable trays are rectangular metal trays and conduits are steel or aluminum tubes that house electrical cables. Raceway supports are constructed primarily of cold-formed steel channel sections and are spaced 8.5 feet apart or less according to the design standard (Reference 16). Exceptions (longer spans) were documented and analyzed separately. There are over 21,000 design class 1 raceway supports in DCNPP-1 which were constructed from approximately 460 standard support details.

2.2.2 Scope of DCP Review

The DCP initially reviewed the seismic design of the electrical raceways and supports. Based upon this initial DCP review, it was decided that all supports would be analyzed. This analysis included a field walkdown and documentation of the type and location of each support.

A transverse analysis was performed for all supports. To provide longitudinal qualification for all Class 1E conduit runs, the DCP conducted a field walkdown of each run. Worst case raceway runs were identified, their as-built conditions documented and analysis performed. All longitudinal cable trays supports were also analyzed.

In addition, the DCP evaluated raceway stresses for maximum spans as described in section 5.4 (EOI 983).

2.2.3 Method for Qualification

The overall DCP approach for qualification of electrical raceways and supports is described in the PGandE Phase I Final Report, Section 2.4. Specific details are documented in design criteria memorandum DCM C-15 Revision 3 (Reference 15).

2.2.3.1 Transverse Analysis

Generic analyses were performed for the 460 standard support configurations as they are shown on the standard detail drawings. The generic analyses were based on maximum allowed member lengths, weights and spectra acceleration from all areas where the support type exists in Unit 1.

As-built analyses were performed for those support types which could not be qualified generically. Procedures and criteria for as-built analyses are identical to the generic analyses; however, they are based on specific rather than generic support dimensions, loading, member size, and plant location.

Transverse analyses considered 7% damping for supports and 15% damping for coupled support/raceway systems. Spectral accelerations were determined for each and the controlling values were used for the stress calculations.

These transverse analyses considered combined transverse and vertical loads.

2.2.3.2 Longitudinal Analysis

Worst case longitudinal conduit runs were identified and their configurations documented.

A conservative simplified procedure was developed to evaluate the conduit runs. The total seismic load in the conduit run was calculated by an equivalent static analysis method taking into account the appropriate floor response spectra. This load was distributed among the supports in proportion to their longitudinal stiffness.

The most heavily loaded and longitudinally flexible raceway/support systems were selected by the DCP for dynamic analysis. The dynamic analyses used finite element methods to determine response behavior and to calculate support loads and stresses.

All longitudinal cable tray supports types were also analyzed.

These longitudinal analyses considered combined longitudinal and vertical loads.

2.2.4 Criteria for Qualification

Design qualification criteria are presented in the PGandE Phase I Final Report, Section 2.4 and Design Criteria Memorandum (DCM) C-15 Rev. 3. These criteria (summarized below) apply to the transverse and longitudinal support analyses.

Seismic Loading

The floor response spectra used for the review and analysis of electrical raceways and supports are the DDE and Hosgri spectra.

For generic calculations worst case (envelope) spectra for all areas where the support type exists are used. In determining the spectral acceleration for generic analyses, the peak value is used if the calculated raceway/support natural period is greater than the period corresponding to 75% of the peak. Otherwise, the spectra ordinate corresponding to the calculated natural period of the support system is used.

For supports evaluated for the specific as-built condition, the applicable directional horizontal acceleration is used. In determining the spectral acceleration, the spectral ordinate corresponding to the calculated natural period of the support system is used. The damping value used is 7% except for the coupled raceway/support analysis (transverse plus vertical). For this coupled analysis, 15% damping is used.

The horizontal acceleration was calculated separately for East-West and North-South directions. These included their respective torsional contributions.

The higher of the two horizontal accelerations was used to calculate the response of the raceway or support. This response was then combined with the response due to vertical seismic acceleration by absolute sum (ABS).

Load Combinations

The raceways and supports are analyzed for deadweight and seismic loads. Directional responses are combined by either ABS or SRSS as discussed above.

Allowable Loads and Stresses

The AISI and AISC codes were used to review the design of the steel members. The faulted condition allowable stress given in the AISC code is increased by 60% as recommended by NRC Standard Review Plan Section 3.8.4 (Reference 17).

Allowable loads on UNISTRUT bolts are taken as 90% of the manufacturer's recommended ultimate values. The allowable loads on concrete expansion anchors are taken as twice the working load specified by the PGandE Engineering Standard (Reference 18). The faulted condition acceptance limit on fillet welds on cold-formed steel members is 60% greater than the allowable given in the AISI code. Unbraced ceiling mounted joints made of angle fittings are checked for rotation and low cycle fatigue.

2.3 INSTRUMENT TUBING AND SUPPORTS

2.3.1 Description

Design Class I instrument tubing is small diameter stainless steel or copper tubing which contains a fluid and runs between a transducer and a sensing device. The fluid (or gases) permit remote indication of sensory information such as temperature or pressure. This tubing typically has very low mass.

Instrument tubing is supported by welded and/or bolted cold-formed steel members and fittings. The majority of Design Class I instrument tubing is within the containment structure.

2.3.2 Scope of DCP Review

The DCP corrective action included review and analysis of all tubing and a representative sample of 88 tubing supports to determine if they were affected by revisions to the 1981 Hosgri spectra.

The sample for review consisted of all tubing supports located in the portions of the containment annulus structure that were adversely affected by these spectra.

2.3.3 Methods for Qualification

The DCP review of instrument tubing and supports was performed by reviewing a sample of 88 supports located in the containment annulus structure. The individual supports selected represented the worst case configurations with respect to support loads and seismic spectra inputs for that configuration type. In addition, tubing spans were reviewed on a generic worst-case basis.

Design of instrument tubing and supports was based on standard drawings. Thus, qualification of a support type was performed by analysis of the worst case.

For the corrective action sample review, the DCP performed field walkdowns to determine the worst-case supports with respect to the longest cantilever sections and largest load on the support. Results of these walkdowns were then used by the DCP in their qualification analyses.

The DCP corrective action work is contained in six analysis packages, designated ITS-1 through ITS-6. ITS-1 addresses the tubing span qualification on a generic basis. ITS-2 through ITS-6 cover the support qualifications, both on a generic worst-case basis and specific as-built basis.

For the supports, each was analyzed to determine the resonant frequencies. In those cases where the resonant frequency was greater than 33 hertz, no further review was performed. If the resonant frequency was less than 33 hertz, a structural analysis was performed with revised spectra to qualify the supports.

If supports did not meet criteria they were reviewed on a case-by-case basis to determine the implications for supports outside of the sample, and whether further samples or modifications were required. If necessary, further sampling and modifications were performed to ensure qualification.

2.3.4 Criteria for Qualification

Spacing of instrument tubing supports was originally designed to maintain tubing natural frequency above the original 20 hertz criteria. For the DCP corrective action review, a worst case analysis was performed to assure that tubing stresses met criteria.

Tubing supports were reviewed with a similar frequency criterion. Where support natural frequency exceeded 33 hertz, the support was considered qualified. If the natural frequency was below 33 hertz, a structural analysis was performed to assure qualification.

3.0 IDVP METHODS

3.1 HVAC DUCTS AND SUPPORTS

The scope of the DCP CAP work, as described in the PGandE Phase I Final Report, was reviewed for completeness and consistency with licensing commitments contained in the FSAR, Hosgri Report (References 20 and 21) and other licensing documents.

The IDVP reviewed specific details of the DCP procedures for CAP work contained DCP design criteria memorandum DCM C-31, Revision 0, Design Methodology HV-4, and individual "design aids".

These criteria and procedures were reviewed for satisfaction of licensing commitments as well as correctness and applicablity of engineering methods.

3.1.1 Sampling/Design Reviews

The IDVP verification of DCP implementation was performed by reviewing sample DCP analyses for conformance with established DCP procedures and criteria.

The IDVP randomly selected samples of DCP reanalyses. A design review checklist (see Appendix A-1) was developed covering all required criteria and procedure items. This checklist included separate items for applicability of methods, completeness and correctness of engineering.

This checklist was supplemented with assessments of the completeness, applicability, consistency and adequacy of the DCP reanalysis methods and results. Where required, alternate calculations were carried out by the IDVP to verify the conclusions of the DCP analysis and/or IDVP assessment. Samples of actual duct and support locations and configurations were field verified.

EOI reports were issued in accordance with IDVP reporting criteria and procedures (Reference 22). A summary of EOIs issued for HVAC ducts and supports is contained in Appendix C.

3.2 ELECTRICAL RACEWAYS AND SUPPORTS

The IDVP reviewed the DCP CAP for electrical raceways and supports as described in the PGandE Phase I Final Report, and the actual implementation of corrective actions. The DCP plan and procedures were reviewed for completeness and consistency with licensing commitments contained in the FSAR, Hosgri Report and other licensing documents.

The IDVP verified the implementation through reviews of DCP analyses.

3.2.1 Sampling/Design Reviews

The DCP performed transverse analyses for each of the existing support types. Engineering judgement was employed by the DCP during site walkdowns to determine conduits runs requiring longitudinal analysis. The IDVP randomly selected samples from among the DCP analyses in each of the two separate areas for review.

The IDVP performed design reviews of each of the sample analyses. These design reviews were performed using checklists, (Appendix B) developed to reflect all required DCP criteria and procedure items. These checklists included separate items for applicability of methods, completeness and correctness of engineering.

These checklists were supplemented with assessments of the completeness, applicability, consistency, and adequacy of DCP analysis methods and results. Where required, alternate calculations were carried out by the IDVP to verify the conclusions of the DCP analysis and/or IDVP assessment. The as-built information used as input to the DCP analyses was field verified by the IDVP on a sample basis.

EOI reports were issued in accordance with IDVP reporting criteria and procedures. A summary of EOIs issued for electrical raceways and supports is contained in Appendix C.

3.3 INSTRUMENT TUBING AND SUPPORTS

The IDVP reviewed the DCP scope and plan for corrective action for instrument tubing and supports as described in PGandE's Phase I Final Report. The DCP CAP involved DCP review and analysis of all tubing and a sample of supports.

The DCP corrective action plan and procedures were reviewed for completeness and consistency with all design commitments. Licensing criteria contained in the FSAR, Hosgri Report and other licensing documents contain no specific structural requirements.

The IDVP reviewed all DCP CAP qualification analyses. This review examined both the appropriateness of the DCP plan for sample qualification based on worst case assumptions, and correctness of the actual analyses.

This IDVP verification by design review was applied to both the generic worst case DCP analyses and the as-built analyses for individual supports that could not be qualified generically.

3.3.1 Design Reviews

The IDVP verified the DCP CAP implementation using review checklists and alternate calculations.

These checklists included items for conformance with design commitments, established DCP procedures, applicability and correctness of engineering methods, and consistency of results. A sample checklist is shown in Appendix A2.

Alternate calculations were carried out in cases where checklist review results were insufficient to verify that supports met licensing criteria. The checklist was supplemented with assessments of the completeness, applicability, consistency, and adequacy of DCP analysis methods and results.

4.0 HVAC DUCT AND SUPPORTS

4.1 DESCRIPTION OF IDVP SAMPLE

The IDVP sample for design review consists of six generic "Design Aid" type packages and twelve specific qualification analyses.

The design aid packages include the detailed algorithm for performing the qualification analyses (HV-4, Reference 23), data tabulation with supporting calculations (HV-1,-2,-3,-72, References 24-27), and a generic calculation generated to address the duct to support connections (HV-290, Reference 28). The design aid packages are discussed in detail in the "methods" sections which follow.

The sample of specific analyses selected for IDVP verification includes two round ducts of 24 and 48 inches in diameter and the associated seismic supports. The remaining ten packages include 14 different sized rectangular ducts and associated seismic supports. The ducts range in size from 10 x 12 inches to 72 x 100 inches; some ducts are covered with fireproofing material or insulation. The specific analyses are described in detail in subsequent sections.

4.2 REVIEW OF DCP METHODS

The IDVP reviewed the DCP methods for performing duct and support analyses as documented in calculation package HV-4 and supported by calculations HV-1, HV-2, HV-3, and HV-72. HV-4 presents a detailed step-by-step procedure for analyzing the ducts and supports based on the more general guidelines and criteria documented in DCM C-31, Revision 0.

Package HV-1 provides a tabulation and HV-2 back-up calculations for the determination of rigid lengths of round and rectangular ducts of all sizes, with and without fireproofing. HV-72 is a compilation of enveloped spectra for flexible slabs in the auxiliary building. Each of these generic design aids was reviewed in detail by the IDVP (References 29-31).

Calculation HV-3 contains the development of an "N" factor for use in determining the effective duct sheet width for the Hosgri analysis of rectangular ducts.

As a result of the IDVP HV-4 review, a sixth generic calculation, HV-290, was generated by the DCP, which addressed the duct-to-support connections. This package was also reviewed by the IDVP.

4.3 RESULTS OF REVIEW

4.3.1 Results of Methodology Review

The results of the IDVP review of HV-4 (Reference 32) indicate that the DCP methods are complete and sufficient to provide for qualification of the duct/support systems. One item was noted concerning lack of procedures for analyzing the duct-to-support connection devices (i.e., bolts, screws or rivets). This was subsequently resolved by HV-290 which specifically addresses these connections on a generic basis. HV-290 was reviewed by the IDVP and found acceptable.

The input data for calculation HV-3 is presented in two proprietary Bechtel documents which were reviewed in the DCP offices. The purpose of the review was to verify the applicability and extent of the testing program from which the data was derived. The results of this review indicate that HV-3 is generally complete, accurate and applicable (Reference 33).

Additional "design aids" (HV-1, HV-2, and HV-72) were reviewed by the IDVP and found acceptable.

4.3.2 Results of Analysis and Design Reviews

The IDVP reviewed twelve HVAC duct and support qualification analyses. Nine of the 12 design review packages have been completed and issued as final. A description of the subject analyses and the results of design reviews are presented in this section.

HV-34

Design analysis HV-34 is the qualification analysis for a new support 59352-23N and the associated duct (Reference 34). The 24 inch x 12 inch rectangular fireproof duct and support are located in Area H of the auxiliary building at elevation 150 feet. The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist.

The IDVP determined that the duct and support meet criteria.

HV-53

Design analysis HV-53 is the qualification analysis for two new supports, 59352-37N and 38N and the associated ducts (Reference 36). The duct is comprised of non-fireproofed 24 x 12, 24 x 8 and 22 x 22 inch rectangular ducts located above the false ceiling of the control room, Area H. The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist.

The IDVP determined that the ducts and supports meet criteria.

HV-59

Design analysis HV-59 provides generic qualification for supports 59352-05, -06, -07, -13 and -14, and the associated duct located above the false ceiling of the control room, Area H (Reference 38). The analysis qualifies the support type with the largest tributary load and the section of duct with the longest span. The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. The following item was noted and resolved in the review:

- The IDVP field verified that only three of the supports existed in the field (-05, -07 and -13). Support 07 was analyzed as the worst case support with a duct tributary length of 15.75 feet. This worst case analysis enveloped the IDVP field verification information.

The above item was evaluated by the IDVP and the duct and supports were determined to meet criteria.

HV-73

Design analysis HV-73 is the qualification analysis for new support 59352-32N and the associated duct (Reference 41). The 24 x 8 inch insulated duct and support are located above the false ceiling of the control room, Area H.

The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. The duct and support were determined to meet criteria.

HV-81

Design analysis HV-81 provides the qualification analyses for three supports, 59353-14, -15, -16, and associated duct (Reference 43). The duct is located in the auxiliary building (Area H, elevation 154 feet - 6 inches) and is comprised of 36 x 24, 16 x 22, 16 x 18 and 16 x 10 inch sections of insulated rectangular duct.

The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist except for the frequency calculation.

As a result of this IDVP design review, and the reviews of HV-86, 87 and 96 described below, EOI 1134 was issued. EOI 1134 reports a concern that the Rayleigh-Ritz Method used in the STRUDL computer code to calculate the ductwork natural period does not predict the first mode fundamental frequency in all cases. In the case of analysis HV-81 this concern has no impact on the results since the support loads used in the DCP analysis are larger than the actual loads.

The DCP analysis calculated a maximum duct bending moment of 73.7 Kip-inches by multiplying the maximum moment from a static "1 g" computer run by the seismic acceleration applicable to the Rayleigh-Ritz frequency.

The IDVP performed a modal analysis using the appropriate seismic response spectra. A modal superposition method was used, combining the first six modal responses by absolute sum. The maximum duct bending moment determined by this method was 58.9 Kip-inches. The IDVP therefore determined that although the fundamental frequency had not been determined, the method for calculating moment and loads did yield conservative results (see section 4.4 - EOI 1134).

The duct and supports were determined by the IDVP to meet criteria.

HV-86

Design analysis HV-86 is the qualification analysis for supports 59353-2, -3, - 4, -30, -32N and -33N, and the associated ducts (Reference 46). The duct system is located in the mechanical equipment room (Area H, elevation 154 feet 6 inches) and is comprised of 24 x 16, 24 x 48, 12 x 10, 36 x 20 and 70 x 20 inch rectangular ducts without fireproofing.

The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. The following item was noted and resolved in the review:

- The frequency resulting from the DCP analysis using the Rayleigh-Ritz method is different from the alternately calculated frequency. The frequencies differ by less than 10%.

The above item was evaluated by the IDVP (see section 4.4 EOI 1134) and the duct and supports were determined to meet criteria.

HV-96

Design analysis HV-96 is the qualification for support 59366-70N and the associated ducts (Reference 47). This duct system is located in the auxiliary building, Area L at elevation 125 feet. It is comprised of a section of 48 inch round duct 3/4 inch thick, a large butterfly valve mounted in line, and a cantilevered section of 48 inch round duct, which is .0359 inches thick (20 gage). The 48 inch duct penetrates the containment exterior shell at elevation 122 feet, and the duct support is located at the containment wall penetration.

The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. The following item was noted and resolved in the review:

- o The duct frequency calculated by STRUDL computer code differed from first mode frequency by 60%. The design analysis shows a frequency of 317 Hz compared to a frequency of 192 Hz alternately calculated by the IDVP. Both frequencies significantly exceed the 33 Hz rigidity criteria.

The above item was evaluated by the IDVP (see section 4.4 EOI 1134) and the ducts and support were determined to meet criteria.

HV-116

Design analysis HV-116 is the qualification of new support 59367-7 and the associated duct (Reference 50). The duct system is located in the purge air supply fan room in Area L at elevation 127 feet. The 48 x 60 inch rectangular duct is neither fireproofed nor insulated. The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. The following item was noted and resolved in the review:

- o DCP sketches and as-built data did not correlate with the support analysis. In addition, DCNs for for modifications were omitted from the documentation package.

The above item was evaluated by the IDVP and the duct and support was determined to meet criteria.

HV-119

Design analysis HV-119 is the qualification analysis for new support 59353-34N (Reference 52). In this case, the associated duct was qualified by calculation HV-81 described above. The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. The following item was noted and resolved in the review:

- o Analysis did not include weight of insulation in determining duct frequency.

The above item was evaluated by the IDVP and the support was determined to meet criteria.

4.4 EOI REPORTS ISSUED

Two EOI reports were issued as a result of the IDVP review of the DCP corrective action with respect to HVAC ducts and supports (see Appendix C).

EOI 1134 was issued as a result of the IDVP review of the DCP Corrective Action Program. The DCP used an approximate procedure to determine a response frequency based on the Rayleigh-Ritz method as performed by the ICES STRUDL II computer code. This procedure was used for the seismic analysis of HVAC duct and supports.

The EOI was issued because, in some cases, frequencies reported by the DCP were significantly different from those alternately calculated by the IDVP. This difference occurred because the DCP frequencies did not always correspond to the first mode natural frequency.

The DCP provided additional information explaining the basis for their approximate method for determining frequency and consequently for determining system seismic response accelerations. The following information was provided by the DCP (Reference 54):

- The method uses an assumed mode shape that results from a static imposition of uniform inertial loads with a 100% participation factor.
- The Rayleigh-Ritz method as applied is not intended to necessarily predict the first mode frequency.
- Mass participation of modes at frequencies lower than those calculated by this method are low or negligible.
- DCP method uses highest acceleration at or above the frequency calculated by this method.
- Accelerations are applied to 110% of the system mass to yield a conservative uniform load.

- o Use of Hosgri effective duct cross sections for both Hosgri and DDE when using STRUDL. The "effective" cross section is smaller than the actual cross section.

A conclusion is drawn by the DCP that, based on the these points, the method used provides for conservative results.

The IDVP reviewed the DCP response and performed alternate calculations to test the DCP conclusion. As a result of these alternate calculations, the IDVP concurs that the approximate procedure does give conservative estimates of the magnitude of duct stresses and support loads. The IDVP found no cases where information provided was incorrect, i.e., the conclusion held for several cases investigated by the IDVP. Therefore the IDVP resolved EOI 1134 as a closed item.

EOI 1143 was issued as a result of the IDVP review of HV-88. The DCP used incorrect revised seismic inputs in the duct/support analysis. This EOI has not been resolved. Resolution of this EOI along with finalization of the IDVP design review will be reported in Revision 1 to this ITR.

EOI 1003 had been issued and classified as an Error Class A or B as a result of the initial IDVP sample. This EOI included the IDVP concern with specific analyses along with overall criteria definition. Following the IDVP review of DCP criteria and CAP implementation to date, this EOI was closed (see Appendix C).

4.5 SUMMARY OF CONCLUSIONS FOR HVAC DUCTS AND SUPPORTS

The IDVP reviewed the DCP corrective action for HVAC ducts and supports. The DCP work reviewed was found to be generally in accordance with the DCP criteria and consistent with the checklists. Differences were noted and evaluated, to date all ducts and supports reviewed meet licensing criteria. Analysis criteria were properly applied, and design analysis methods were found to be acceptable.

Results from the three design reviews not yet completed and effects of future revisions to seismic inputs (completion sample) remain to be evaluated. These will be reported in Revision 1 to the ITR.

5.0 ELECTRICAL RACEWAYS AND SUPPORTS

5.1 DESCRIPTION OF THE IDVP SAMPLE

The IDVP sample selected for the transverse and vertical qualifications consisted of 17 analyses selected from a total of approximately 460 support types. These support types were chosen as representative of a variety of configurations, locations, loading conditions, and analysis types (i.e., generic, as-built, or modified).

For the longitudinal qualification, the IDVP selected a sample of seven analyses of conduit runs in various areas of the plant with emphasis on those areas with high seismic response spectra. Five of these analyses are static equivalent analyses performed internally by the DCP. Two are dynamic analyses performed by a service related contractor to the DCP.

5.2 REVIEW OF DCP METHODS

The IDVP reviewed the overall DCP methodology contained in the PGandE Phase I Final Report, Section 2.4.3.1. The specific methodology and procedures are documented in DCM C-15 Rev. 3.

The IDVP reviewed the specific methodology in DCM C-15 Rev. 3. This review assumed that the manufacturer's load values were not affected by the Midland Ross Superstrut weld concerns (Reference 68).

The purpose of this review was to determine the adequacy of the DCP methodology and procedures in satisfying the licensing requirements.

5.3 RESULTS OF REVIEW

5.3.1 Results of Methodology Review

As a result of the IDVP Phase I initial sample several concerns involving the DCP methodology were reported in ITR #7 (Reference 57). In addition, several questions resulted from the specific review of DCM C-15 Rev. 2 and Rev. 3. The resolutions for these concerns and questions are documented in the design review package for DCM C-15 Rev. 3. Resolution of IDVP previous concerns is discussed in detail in section 5.4 (EOI 983).

The conclusion of the methodology design review is based on review of DCM C-15 Rev. 2, Rev. 3, and the ongoing review of the resulting analysis packages. On the basis noted above the IDVP finds the procedures, methodology and criteria for performing the qualification of electrical raceway supports to be consistent with the licensing criteria and acceptable.

5.3.2 Results of Analysis Design Reviews

The IDVP reviewed seventeen transverse analyses. Of these, thirteen reviews have been completed and issued as final. To date, reviews of longitudinal analyses have not been finalized.

S-15B

Support analysis S-15B is an as-built analysis using the worst case configuration of three actual supports of similar type. The analysis used generic weights for the attached cable trays and conduits based on sizes indicated from as-built data.

The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. In addition, the IDVP performed an alternate calculations which yielded the same frequency (17.7 Hz) as the design analysis. The IDVP determined that the supports met criteria.

S-80B

Support analysis S-80B is an as-built analysis based on generic weights and the worst case configuration of seven similar supports. The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. The following items were noted and resolved in the review:

- o The design analysis did not consider the support deadweight.
- o The design analysis did not explicitly evaluate column stability.

The above items were evaluated by the IDVP and the supports were determined to meet criteria.

S-116

Support analysis S-116 is a generic analysis based on the standard detail drawing 050030, Revision 29, configuration. The support was qualified based on a modification to the as-designed configuration. The design change notice (DCN) is included in the package and dictates the addition of an S-6 type brace.

The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. The support was determined to meet criteria.

S-184

Design analysis S-184 is an as-built analysis of a single support in the cable spreading room. The analysis used generic weights for the attached conduit and accounted for a modification indicated on a DCN included in the package.

The IDVP design review found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. The IDVP determined that the support meets criteria.

S-262

Design analysis S-262 is an as-built analysis of six supports of the same generic type within the containment structure. The analysis is performed for an envelope worst case configuration.

The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. The following item was noted and resolved in the review:

- One of the as-built supports had a member length slightly longer than the length used. However, this support had smaller loads compared to the envelope case analyzed, and therefore, analysis results are conservative for all six configurations.

The above item was evaluated by the IDVP and the supports were determined to meet criteria.

S-314

Design analysis S-314 is a generic analysis of the as-designed support configuration from the PGandE standard support drawing (050030, Revision 25). The support is qualified using the maximum allowed number of attached conduits at the maximum span, and generic weights were used.

The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. The following item was noted and resolved in the review:

- o The design analysis did not consider the support deadweight.

The above item was evaluated by the IDVP and the support was determined to meet criteria.

S-340

Design analysis S-340 is a generic calculation qualifying two supports in the auxiliary building area K at elevation 100 feet.

The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. The IDVP determined that the supports meet criteria.

S-345

Design analysis S-345 is an as-built analysis for 28 actual supports in various areas of the plant. A generic analysis based on maximum generic loads, maximum dimensions and an envelope of spectra from all applicable areas did not provide qualification. Therefore, as-built conditions were analyzed by the DCP for the seven distinct areas of the plant where the supports exist.

The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. In addition design analysis and IDVP alternate calculations agree.

		Frequencies (hertz)	
Direction	Mode	DCP	IDVP
X	1	6.09	6.09
Y	2	20.49	20.49

The IDVP determined that this support meets criteria.

S-424

Design analysis S-424 is an as-built analysis for one support located in the cable spreading room. A generic analysis based on generic weight and as-built conduit sizes and spans did not provide qualification. Therefore, as-built weights were used in the analysis.

The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist.

Based upon the review together with alternate calculations, the IDVP determined that the support meets criteria.

S-426

Design analysis S-426 is an as-built analysis for 11 supports in various areas of the plant. Of these supports, 10 were qualified without modifications using as-built configurations including conduit spans and weights. One support required modifications to meet allowables.

The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. The IDVP determined that the supports meet criteria.

S-562

Design analysis S-562 is a generic analysis of eight electrical junction box supports located in the containment structure. The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. The following item was noted and resolved in the reivew:

- o Analysis neglected deadweight of the support structure and did not apply peak accelerations. However, the DCP analysis used twice the approximate weight of the attached box.

The above item was evaluated by the IDVP and the supports were determined to meet criteria.

S-599

Design analysis S-599 is an as-built analysis of a single support located in the auxiliary building in Area J at elevation 115 feet. The analysis uses generic conduit weights and actual conduit spans to determine loads.

The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. The IDVP determined that the support meets criteria.

S-623

Design analysis S-623 is an as-built analysis for two supports inside the containment building at elevations 140 and 117 feet. The IDVP found the analysis to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. The following item was noted and resolved in the review:

- o DCP computer model did not fully account for proper boundary conditions and for all restraint reactions.

The above item was evaluated by IDVP alernate calculations and the supports were determined to meet criteria.

5.4 EOI REPORTS ISSUED

No EOI reports were issued as a result of the IDVP review of the DCP corrective actions with respect to electrical raceways and supports.

EOI 983 had been issued and classified as an Error Class A as a result of the initial IDVP sample, to document the following:

- o Installation Concern

- o Criteria Concerns

  1. Longitudinal support for conduits is not specified in any installation drawings and was not checked by PGandE in the qualification analysis.

  2. Raceway stresses calculated for the largest design span may exceed allowable.

  3. Joint fatigue and local joint flexibility may result in more flexible supports are characterized by higher seismic accelerations.

  4. Flexibility of adjacent supports may change the effective load distribution of the support being examined. This may result in higher seismic accelerations.

  5. The design methodology does not consider the coupling of support and raceway in determining frequency. This may result in lower frequencies and higher seismic loadings.

  - o Response Spectra Input Concern

These concerns have been addressed by the DCP and EOI 983 resolved (see Appendix C). The IDVP has verified design analyses addressing the installation concern. In addition, the revised raceway and support criteria have been verified by the IDVP to address criteria concerns 1, 3, 4 and 5 and the response spectra input concern. Criteria concern 2 is addressed by a design analysis to be reviewed by the IDVP and reported in revision 1 of this ITR.

5.5 SUMMARY OF CONCLUSIONS FOR ELECTRICAL RACEWAYS AND SUPPORTS

The IDVP reviewed the DCP corrective action for electrical raceway supports. The DCP work reviewed was found to satisfy licensing criteria. The seismic inputs used were consistent with the date of the analysis and were determined to be correct. Analysis criteria were properly applied, and design analysis methods were found to be in accordance with licensing criteria.

For the transverse analyses, 13 of 17 design reviews have been issued as final. Design reviews for five longitudinal analyses (including both the equivalent static and dynamic) have been completed but are not finalized.

Results from design reviews not yet completed and effects of future DCP revisions to seismic inputs on electrical raceway supports remain to be evaluated. Revision 1 of this ITR will report these IDVP verification results.

6.0 INSTRUMENT TUBING AND SUPPORTS

6.1 Description of IDVP Sample

The DCP selected a representative sample of 88 tubing supports for analysis to determine if they were affected by revisions to the 1981 Hosgri spectra. All of the samples were taken from portions of the annulus structure that were adversely affected by these revised spectra.

All the DCP analyses were contained in six calculation packages, designated ITS-1 through ITS-6. The package ITS-1 addressed tubing span qualification through the spacing of tubing supports; ITS-2 through ITS-6 were for the purpose of qualifying the tubing supports themselves.

6.2 Review of DCP Methods

IDVP verification of the DCP CAP included examination of DCP sampling methods, analysis criteria and procedures. Sample size requirements were examined to determine if generic conclusions for the instrument tubing and supports could be drawn through application of the sampling methodology. The sample space from which the DCP selected their corrective action review sample was the entirety of instrument tubing and supports for Design Class 1 instrument systems.

The IDVP reviewed the DCP criteria against licensing commitments contained in the FSAR, Hosgri Report, Safety Evaluation Reports and supplements, and other licensing documents.

Verification of the DCP corrective action implementation was carried out through reviews of six qualification analysis packages, ITS-1 through ITS-6. These reviews were conducted using IDVP checklists compiled to reflect technical items in the DCP plan procedures.

All tubing supports were originally designed to a single standard, Reference 69. This standard specified design details such that supports had minimum first mode frequencies of 20 Hz. The DCP review used a basic criteria for the adequacy of the supports based on minimum frequencies of 33 Hz. If the natural frequency was greater than 33 hertz, the support was qualified. Where the natural frequency was less than 33 Hz, a structural analysis was performed for qualification.

The IDVP field verified selected details and dimensions in the qualification calculations. In addition, overall modeling techniques and methodology were verified on the basis of familiarity with the installed configurations.

6.3 RESULTS OF REVIEW

The IDVP reviewed the DCP sampling methodology to verify the appropriateness and adequacy of the sample as a basis for plantwide conclusions. The majority of tubing and supports in the annulus represent worst case configurations. Therefore, the IDVP concluded that the DCP sample methodology was appropriate, and that the sample of 88 supports and review of tubing was adequate to provide plantwide qualification conclusions.

DCP Calculation ITS-1, Revision 0

Instrument tubing calculation ITS-1 is a generic calculation which shows that for the maximum tubing spans, as given in the design specification, stresses due to the postulated 7.5M Hosgri earthquakes meet allowables.

In reviewing ITS-1, the IDVP found it necessary to use the following three step procedure:

Step one: Verify that input data was identical to that contained in the applicable design documents.

Step two: Verify that analytical methods and formulas were applicable to the purpose of the calculation and were utilized correctly.

Step three: Verify numerical accuracy, validity of assumptions and results, and ensure that results meet allowables.

From this design review of ITS-1, the IDVP noted that:

- o All input data were identical with or directly derivable from documented values.
- o Methods and formulas applied were correct.
- o Calculations were accurate, assumptions and results were valid, and allowables were met for stainless steel and copper tubing.

The IDVP therefore considers ITS-1 is adequate and meets licensing criteria for Hosgri loadings for the instrument tubing span.

DCP Calculation ITS-2 Revision 1

Instrument tubing support calculation ITS-2, Revision 1 qualifies three generic support types by comparison to maximum loads and cantilever arm lengths generated in ITS-2, Revision 0. ITS-2, Revision 0 is a generic calculation, which modifies allowable loads and cantilever arm lengths as given in the standard tubing support drawings, based on a conservative support flexibility criteria of 40 Hz. To qualify the three support types in ITS-2, Revision 1, worst-case as-built configurations were compared to the modified allowables.

The IDVP reviewed ITS-2 using a written checklist. The results of the review indicate that ITS-2 does not follow the established DCP analysis methodology.

Therefore, the IDVP performed alternate calculations, following the DCP procedures, to verify the structural adequacy of the three support types. The IDVP calculated the natural frequencies of the three support types and determined that they all met the qualification criteria of 33 Hz.

The IDVP concluded that the subject supports meet the qualification criteria.

DCP Calculation ITS-3, Revision 1

Instrument tubing calculation ITS-3 qualifies four support types using as-built configurations.

The IDVP review of ITS-3 was performed using a written checklist. The results of the review indicated that DCP calculation ITS-3 does not follow the established DCP analysis methodology. The IDVP therefore performed alternate calculations to verify the structural adequacy of the subject supports. The results of the alternate calculations indicate that the four supports presented in ITS-3 meet the qualification criteria.

DCP Calculation ITS-4, Revision 1

Instrument tubing support calculation ITS-4 contains the qualification analyses for five support types. Each support type is an application of generic support drawing FS-342-149-29. The IDVP found three of the five support analyses were generally in accordance with the DCP criteria and consistent with the IDVP checklist.

The remaining two support analyses contained the following differences requiring further IDVP review:

- o Incomplete support weight
- o Unreferenced seismic acceleration coefficients are lower than the latest spectra acceleration values
- o Analytical methods which may have provided unconservative results.

The IDVP was able to resolve these differences by alternate calculations and further review, as documented in the final design review for ITS-4. The IDVP concluded that the five support types are structurally adequate and meet established criteria.

DCP Calculation ITS-5, Revision 1

Instrument tubing support calculation ITS-5 is a two part package consisting of Revisions 0 and 1 which together provide qualification for seven support types. Revision 1 of ITS-5 considers the effect of revised seismic inputs on results reported in Revision 0.

The IDVP found four of the seven support types included in ITS-5 to be generally in accordance with the DCP criteria and consistent with the IDVP checklist. One support type was removed from the plant.

Calculations for one support did not account for the tubing tributary load in either the frequency or stress calculation. However, IDVP field verification determined that this particular support configuration was not installed in the plant. Thus, the tributary load consideration was not significant.

The remaining support used an assumed member size and section property which did not agree with the as-built member size. The DCP showed that the original assumption was conservative and all stresses were below allowables if the actual as-built member properties was used. This discrepancy is reported in EOI 1123.

The IDVP concluded that all existing supports analyzed in ITS-5 meet the qualification criteria.

DCP Calculation ITS-6, Revision 1

Instrument tubing support calculation ITS-6 qualified eight types of supports. The analyses were based on as-built information.

The IDVP performed the review using a written checklist. The results of this review indicated numerous procedural and computational differences. In addition, the DCP as-built information was field verified by the IDVP with the following results:

- One support type did conform to DCP as-built information.

- Two of the supports analyzed no longer exist.

- Four of the supports carried loads greater than those used in the DCP analysis.

- One support could not be located in the field.

The IDVP performed alternate calculations, using IDVP field verified information and following DCP procedures.

For the support not located in the field, alternate hand calculations were performed by the IDVP to justify the DCP as-built data, specifically the attached load. Results of these calculations (contained in the design review package) indicated that the values used in the qualification analysis are conservative and results meet established criteria. The alternate calculations indicate that the subject supports meet the established criteria.

General Field Verification

The IDVP selectively field verified sixteen support types in designated areas of the annulus region. These support types were documented by the DCP with as-built data used as input to the calculation packages ITS-2 through ITS-6. The DCP field information represents worst-case configurations when more than one support of a particular type exists in the area under consideration. These supports were documented by the DCP as a result of a walkdown in specific areas of the containment annulus (Reference 95).

The purpose of the IDVP verification efforts was to determine validity of worst-case data by verifying general configuration and loadings of support types.

Where possible (i.e., where support types represent one or few actual supports), the IDVP verified the support-specific data as documented by the DCP. Where supports were identified by the DCP as unique or heavily loaded configurations, specific worst-case support were located and verified.

The results of the IDVP field verification effort indicate that the DCP as-built information is acceptable for twelve of the sixteen types documented. Either the DCP as-built data accurately represents the support verified by the IDVP or the supports no longer exist.

The four exceptions to this were unique configurations on one particular run of instrument tubing. These supports were found to carry loads greater than those documented by the DCP. The IDVP field verified data was taken into account in performing the review of the qualification analyses for these supports (see ITS-6 review). In no case did the increased loads affect the results of the review.

Based on the field verification performed to date, the IDVP concluded that the DCP analyses adequately incorporated existing as-built conditions. Minor differences were noted, but these had no impact on analysis results.

6.4 EOI REPORTS ISSUED

One EOI report was issued for instrumentation tubing and tubing supports. Appendix C shows the EOI file number, revision, data, and status.

EOI 1123 reports a difference between the support configuration considered in the qualification analysis ITS-5, and the field verified configuration of the support.

The original calculation had used unconservative assumptions for the support configuration. Calculations performed by the DCP and verified by the IDVP that used the actual data for of the support configuration show all stresses to be below allowable criteria.

Since all stresses were below allowable criteria, EOI 1123 was resolved as an Error Class C.

6.5 SUMMARY OF CONCLUSIONS FOR INSTRUMENT TUBING AND SUPPORTS

The IDVP has verified the DCP program for qualification of Design Class I instrument tubing and supports. The review included examination of both the DCP plan and its implementation.

Plan implementation was verified through examination of the DCP sampling, design reviews of completed DCP analyses, and field verification.

Based on the design reviews and field verification performed to date, the IDVP concluded that the instrument tubing and tubing support were designed in compliance with licensing requirements.

7.0 SUMMARY OF REVIEW RESULTS

The following results summary is based on IDVP methodology reviews and analysis design reviews completed and issued as final.

HVAC Ducts and Supports

The IDVP has issued six final methodology review packages. This represents a complete review of the DCP methodology, procedures and criteria. Based on the results of these design review packages the IDVP accepts the DCP methodology as adequate to satisfy licensing requirements with no further review necessary.

Nine of twelve design reviews of actual qualification analyses have been issued as final by the IDVP. The design reviews show the ducts and supports to meet licensing criteria.

The three additional design reviews are in the process of finalization. The results of these design reviews will be reported in Revision 1 to this report.

Electrical Raceway Supports

The IDVP has issued a design review package for the methodology as contained in DCP DCM C-15 Revision 3. The results of this review indicated that the methodology employed in the reanalyses of electrical raceways and supports is adequate to satisfy licensing requirements.

Thirteen of seventeen design review packages for the transverse raceway support analyses have been issued as final. The results of these reviews demonstrate that in general the DCP qualifications are complete and in compliance with established criteria.

Minor procedural and computational differences were noted in the design review packages. The IDVP assessed the impact of these differences and found that in all cases, licensing criteria were met. The IDVP therefore finds the DCP transverse qualification analyses acceptable.

The four remaining transverse analysis design reviews are in the process of finalization. The results of these will be reported in Revision 1 of this report.

The IDVP has completed but not yet finalized five reviews of DCP longitudinal analyses. The complete description, discussions and results will be included in Revision 1 to this ITR. The IDVP does not presently anticipate significant concerns involving these qualifications based on the reviews performed to date.

As a result of NRC Board Notification 83-14 the DCP performed an in depth review of fabrication practices used for Midland- Ross "Superstrut" cold formed structural members at DCNPP. In addition, a test program was performed, and it is understood that the DCP is continuing this work with a study of the structural requirements for connections in cold formed structural members.

Reference was made to this work by the NRC in a recent meeting, relative to the IDVP effort. The IDVP has considered this work to be outside present scope, and therefore has not reviewed the DCP work related to "Superstrut" members.

Instrument Tubing

The IDVP has completed all methodology and analysis design reviews for instrument tubing and tubing supports.

The results of the methodology review indicate that the procedures and criteria are sufficient to demonstrate the structural adequacy of the subject tubing and supports. Although no explicit licensing requirement exist, the IDVP determined the DCP program for this subject is conservative and consistent with programs developed for other systems and components within DCNPP-1.

The design review results based on the qualification analyses demonstrate that the subject tubing and supports are adequate to withstand the postulated Hosgri event. The analysis packages were not, in all cases, consistent with the DCP criteria and procedures. The IDVP was able, in all cases, to verify the structural adequacy of the supports. This was performed by the combined use of design reviews and alternate calculations. Therefore the IDVP finds the DCP CAP for instrument tubing and supports acceptable to meet the general provisions of the licensing requirements.

8.0 CONCLUSION

The IDVP has reviewed the DCP methodology, procedures and criteria for the corrective action program as documented in this ITR. Based on the results of the methodology reviews for HVAC duct and supports, electrical raceways and supports, and instrument tubing and supports, the IDVP concludes the following:

- o The CAP adequately addressed the Design Class I components listed above.
- o The CAP methodologies for these components were generally complete and met applicable licensing criteria.
- o The DCP procedures and criteria provide adequate guidance for performing the qualification analyses for these components.

To verify the implementation of the DCP corrective action program the IDVP selected a representative sample of qualification analyses for the three component disciplines covered by this ITR. Detailed design reviews were performed and selected as-built conditions were field verified. Based on the design reviews issued as final and the field verification performed to date the IDVP concludes the following:

- o Analyses adequately incorporated as-built conditions
- o Analyses were in general complete and in compliance with documented DCP procedures and criteria
- o Subject components met licensing criteria.

The IDVP therefore concludes, based on the results to date, that the design Class I HVAC ducts and supports, electrical raceways and supports, and instrument tubing and supports were designed in compliance with applicable licensing requirements.

Revision 1 of this ITR will report the results of the balance of the field verification and reviews along with the completion sample and field verification of CAP modifications.

9.0 REFERENCES

Reference No.	Title	RLCA File No.
1	Pacific Gas and Electric Company (PGandE), Phase I Final Report - Independent Design Verification Program, Diablo Canyon Nuclear Power Plant, June 21, 1983.	P105-4-200-117
2	Independent Design Verification Program (IDVP), Interim Technical Report (ITR) #8, Verification Program for PGandE Corrective Action, Revision 0, October 5, 1982.	P105-4-839-008
3	IDVP, ITR # 35, Verification Plan for Diablo Canyon Project Activities, Revision 0, March 1, 1983.	P105-4-839-035
4	DCNPP IDVP, Phase I, Program Management Plan, Revision 1 July 6, 1982. Revision 0, March 24, 1983.	
5	IDVP, Diablo Canyon Nuclear Power Plant Unit 1, Final Report, 1983.	
6	PGandE Specification No. 8827, Specification for Furnishing and Installing of Design Class I Heating and Ventilation Systems for Unit I - Diablo Canyon Site.	P105-4-436-002
7	PGandE Specification No.8771 Specification for Furnishing and Installing Control Room Ventilation and Pressurization System for Unit I - Diablo Canyon Site.	P105-4-410-008

Reference No.	Title	File No.
8	DCP Analysis Package HV-116, HVAC Ducts and Duct Supports, Support 59367-07, Revision 1.	P105-4-436-056
9	DCP Design Criteria Memorandum (DCM) C-31, Design Criteria for Seismic Review of Class 1 Ducts and Duct Supports, Revision 0.	P105-4-200-005
10	DCP Analysis Package HV-4, HVAC Ducts and Duct Supports: Design Verification Methodology, Revision 1.	P105-4-436-032
11	DCM C-17, Hosgri Response Spectra for Structures, Systems and Components.	P105-4-200-100
12	DCM C-30, Double Design Earthquake Response Spectra for Structures, Systems and Components.	P105-4-200-056
13	American Iron and Steel Institute (AISI), Specifications for Design of Cold-formed Steel Structural Members.	
14	American Institute of Steel Construction, Manual of Steel Construction, 7th and 8th Editions.	
15	DCM C-15, Electrical Raceway Supports, Revision 3.	P105-4-410-009
16	PGandE Drawing Number 050030, Notes, Symbols and Typical Details for Design Class 1E Electrical Raceway Supports, Change 29.	P105-4-456-198
17	NRC, NUREG-0800, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, July 1981.	

Reference No.	Title	File No.
18	PGandE Drawing 054162, Allowable Loads for Concrete Expansion Anchors for Static and Seismic Loads, Revision 3.	P105-4-456-058
19	PGandE DCM M-9, Design of Pipe Supports, Revision 7.	P105-4-200-___
20	Diablo Canyon Site Units 1 and 1, Final Safety Analysis Report, USAEC Docket Nos. 50-275 and 50-323.	P105-4-200-005
21	Seismic Evaluation for Postulated 7.5M Hosgri Earthquake, USNRC Docket Nos. 50-275 and 50-323.	P105-4-200-001
22	IDVP, Program Procedure, Preparation of Open Item Reports, Error Report, Program Resolution Reports and IDVP Completion Reports, DCNPP-IDVP-PP-003, Revision 1, June 18, 1982.	P105-4-436-032
23	DCP Analysis Package HV-4, HVAC Ducts and Duct Supports: Design Aid Revision 1.	P105-4-436-031
24	DCP Analysis Package HV-1, HVAC Ducts and Duct Supports: Design Aid #1, Revision 1.	P105-4-436-029
25	DCP Analysis Package HV-2, HVAC Ducts and Duct Supports: Backup Calculations For Design Aid #1, Revision 1.	P105-4-436-030
26	DCP Analysis Package HV-3, HVAC Ducts and Duct Supports, Development of "n" Factor, Revision 0.	P105-4-436-031
27	DCP Analysis Package HV-72, HVAC Ducts and Duct Supports, Design Aid #3, Revision 0.	P105-4-436-033

Reference No.	Title	File No.
28	DCP Analysis Package HV-290, HVAC Ducts and Supports, Duct to Support Interface Connection Assessment, Revision 0.	P105-4-436-090
29	RLCA Final Design Review, HV-1, Revision 0.	P105-4-506-050
30	RLCA Final Design Review, HV-72, Revision 0.	P105-4-506-049
31	RLCA Final Design Review, HV-2, Revision 0.	P105-4-506-049
32	RLCA Final Design Review, HV-4, Revision 0.	P105-4-506-098
33	RLCA Final Design Review, HV-3, Revision 0.	P105-4-506-096
34	DCP Analysis Package HV-34, HVAC Duct and Duct Supports, 59352-23N, Revision 0.	P105-4-436-052
35	RLCA Final Design Review, HV-290, Revision 0.	P105-4-506-136
36	DCP Analysis Package HV-53, HVAC Duct and Duct Supports, 59352-37N and 38N, Revision 0..	P105-4-436-038
37	RLCA Final Design Review, HV-34, Revision 0.	P105-4-506-090
38	DCP Analysis HV-59, HVAC Duct and Duct Supports, Support Nos. 59352-05, -06, -07, -13, -14, Revision 0.	P105-4-436-092
39	RLCA Final Design Review, HV-53, Revision 0.	P105-4-506-048
40	RLCA Field Verification Reconciliation.	P105-4-591.5-239

Reference No.	Title	File No.
41	DCP Analysis Package HV-73, HVAC Ducts and Duct Supports, Support 59352-32N, Revision 0.	P105-4-436-039
42	RLCA Final Design Review, HV-59, Revision 0.	P105-4-506-126
43	DCP Analysis Package HV-81, HVAC Ducts and Duct Supports, Supports 59353-14,-15, and -16, Revision 1.	P105-4-436-053
44	RLCA Final Design Review, HV-73, Revision 0.	P105-4-506-086
45	RLCA Final Design Review, HV-81, Revision 0.	P105-4-506-119
46	DCP Analysis Package HV-86, HVAC Ducts and Duct Supports, Supports 59353-2, -3, -4, -30, -32N and -33N, Revision 1.	P105-4-436-093
47	RLCA Final Design Review, HV-86, Revision 0.	P105-4-506-127
48	DCP Analysis Package HV-96, HVAC Ducts and Duct Supports, Support 59366-70N, Revision 1.	P105-4-436-057
49	RLCA Final Design Review, HV-96, Revision 0.	P105-4-506-059
50	DCP Analysis Package HV-116, HVAC Ducts and Duct Supports, Support 59367-7, Revision 1.	P105-4-436-056
51	RLCA Final Design Review, HV-116, Revision 0.	P105-4-506-115
52	DCP Analysis Package HV-119, HVAC Ducts and Duct Supports, Support 59353-34N, Revision 1.	P105-4-506-055
53	RLCA Final Design Review, HV-119, Revision 0.	P105-4-506-093

Reference No.	Title	File No.
54	DCP Resolution Sheet, EOI 1134.	P105-4-1134-002
55	DCP DCM C-15, Electrical Raceway Supports, Revision 3.	P105-4-410-009
56	RLCA Preliminary Design Review (C-15) Revision 0	P105-4-597-210
57	IDVP, ITR #7, Electrical Raceway Supports, Revision 0.	P105-4-839-007
58	DCP Analysis Package S-15B, Class 1E Electrical Raceway, Revision 0.	P105-4-434-035
59	RLCA Final Design Review, S-15B, Revision 0.	P105-4-506-080
60	DCP Analysis Package S-80B, Electrical Raceway Supports, Revision 1.	P105-4-434-036
61	RLCA Final Design Review, S-80B, Revision 0.	P105-4-506-082
62	DCP Analysis Package S-116, Class 1E Electrical Raceway, Revision 0.	P105-4-434-037
63	RLCA Final Design Review, S-116, Revision 0.	P105-4-506-079
64	DCP Analysis Package S-184, Electrical Raceway Supports, Revision 1.	P105-4-434-039
65	RLCA Final Design Review, S-184, Revision 0.	P105-4-506-078
66	DCP Analysis Package S-262, Electrical Raceway Supports, Revision 0.	P105-4-434-033
67	RLCA Final Design Review, S-262, Revision 0.	P105-4-506-083
68	NRC Board Notification 83-14 - "Midland-Ross" superstrut issue	

Reference No.	Title	File No.
69	PGandE Drawing 049238, Instrument Tubing Supports, Change 9.	P105-4-456-211
70	DCP Analysis Package S-314, Class 1E Electrical Raceway Revision 0.	P105-4-434-043
71	RLCA Final Design Review, S-314, Revision 0.	P105-4-506-067
72	DCP Analysis Package S-345, Class 1E Electrical Raceway Supports, Revision 0.	P105-4-434-032
73	RLCA Final Design Review, S-345, Revision 0.	P105-4-506-011
74	DCP Analysis Package S-424, Electrical Raceway Supports, Revision 1.	P105-4-434-038
75	RLCA Final Design Review, S-424, Revision 0.	P105-4-506-088
76	DCP Analysis Package S-426, Electrical Raceway Supports, Revision 2.	P105-4-434-041
77	RLCA Final Design Review, S-426, Revision 0.	P105-4-506-084
78	DCP Analysis Package S-562, Electrical Raceway Support, Revision 1.	P105-4-434-034
79	RLCA Final Design Review, S-562, Revision 0.	P105-4-506-013
80	DCP Analysis Package S-599, Electrical Raceway Supports, Revision 1.	P105-4-434-042
81	RLCA Final Design Review, S-599, Revision 0.	P105-4-506-068
82	DCP Analysis Package S-623, Class 1E Electrical Raceway, Revision 0.	P105-4-434-046

Reference No.	Title	File No.
83	RLCA Final Design Review, S-623, Revision 0.	P105-4-506-076
84	PGandE Calculation No. ITS-1, Instrument Tubing Supports, Revision 0.	P105-4-438-014
85	PGandE Calculation No. ITS-2, Instrument Tubing Supports, Revision 1.	P105-4-438-014
86	PGandE Calculation No. ITS-3, Class 1 Instrument Tubing Supports, Revision 1.	P105-4-438-012
87	PGandE Calculation No. ITS-4, Pipe Support, Revision 1.	P105-4-438-014
88	PGandE Calculation No. ITS-5, Instrument Tubing Supports, Revision 0.	P105-4-438-016
89	PGandE Calculation ITS-6, Pipe Support, Revision 1.	P105-4-438-017
90	RLCA Final Design Review, ITS-1, Revision 0.	P105-4-506-017
91	RLCA Final Design Review, ITS-2, Revision 0.	P105-4-506-019
92	RLCA Final Design Review, ITS-3, Revision 0.	P105-4-506-025
93	RLCA Final Design Review, ITS-5, Revision 0.	P105-4-506-087
94	RLCA Final Design Review, ITS-6, Revision 0.	P105-4-506-016

Reference No.	Title	File No.
95	PGandE Response to RFI 363, Instrument Tubing Supports, As-Built Sketches.	P105-4-437-013
96	RLCA Final Design Review, Instrument Tubing and Tubing Supports - Sampling.	P105-4-506-036
97	RLCA Final Desing Review, ITS-4.	P105-4-506-037

Duct Diameter (inches)	Gage (United States Standard Gage)
less than 9	26
9 - 22	24
23 - 36	22
37 - 50	20
51 - 60	18
61 - 84	16

Table 1

Round Ducts - Sheet Steel Gage

Larger Dimension of Duct (inches)	Gage (United States Standard Gage)
less than 19	24
19 - 48	22
49 - 72	20
73 or over	18

Table 2

Rectangular Ducts - Sheet Steel Gage

Duct Diameter (inches)	Minimum Reinforcing Angle Size	Maximum Distance Between Reinforcing Angles of Joints
less than 37	-	-
37- 60	1-1/4"x 1-1/4"x 1/8"	6 feet
61 - 84	1-1/2"x 1-1/2"x 1/8"	4 feet

Table 3

Round Ducts - Stiffeners

Larger Dimension of Duct (inches)	Maximum Reinforcing Angel Size	Maximum Distance Between Reinforcing Angles of Joints
less than 13	-	-
13 - 24	1" x 1" x 1/8"	4 feet
25 - 36	1-1/4"x 1-1/4"x 1/8"	3 feet 4 inches
37 - 48	1-1/2"x 1-1/2"x 1/8"	2 feet 6 inches
49 - 96	1-1/2"x 1-1/2"x 1/8"	2 feet
97 and over	2" x 2" x 1/8"	2 feet

Table 4

Rectangular Ducts - Stiffeners

Appendix A

Sample Checklists

Robert L. Cloud and Associates, Inc.

RLCA

Appendix A1

Sample Checklists

HVAC Ducts and Supports

(11 pages)

HVAC CHECKLIST

By__________Date__________ Page________of________

RLCA Review of Class I HVAC Ducts and Supports

Duct/Support:____

		Satisfactory		
		Yes	No	Comment
1.0	GENERAL COMMENTS			
1.1	The design criteria shall be clearly established.	____	____	________
1.2	Are all assumptions defined and reasonable?	____	____	________
1.3	Are methods reasonable and clearly defined?	____	____	________
1.4	Are computer programs used properly and verified.	____	____	________
1.5	Are results in general reasonable.	____	____	________
1.6	Have all mathematical computations been executed correctly?	____	____	________
1.7	Have all formulae been used correctly and referenced.	____	____	________
1.8	Is the design analysis complete?	____	____	________

HVAC CHECKLIST

By________Date________ Page________of________

RLCA Review of Class I HVAC Ducts and Supports

Duct/Support:______________________________

	Satisfactory		
	Yes	No	Comment
2.0 CODES AND STANDARDS			
2.1 Design verification of ductwork shall conform to the applicable portions of the codes and standards listed in DCM C-31 (Ref.1) Section 2.0, unless stated otherwise within Ref. (1).			
2.2 Have all codes and standards, which have been used, properly referenced.	____	____	________
3.0 SELECTION OF CRITICAL SUPPORT			
3.1 Are supports grouped into similar (generics) types in accordance with DCM C-31 Sect. 7.0.	____	____	________
3.2 Selection of the critical support, within the generic group, shall consider the following items:			
3.2.1 Dynamics - boundary conditions, location from building center of mass, system flexibility, etc.	____	____	________
3.2.2 Support location with respect to applicable response spectra.	____	____	________

HVAC CHECKLIST

By__________Date__________ Page_________of_________

RLCA Review of Class I HVAC Ducts and Supports

Duct/Support:____

		Satisfactory		
		Yes	No	Comment
3.2.3	System period relative to peak response.	____	____	__________
3.2.4	Total weight acting on the support.	____	____	__________
3.2.5	Strength of supporting concrete and anchor bolts.	____	____	__________
3.3	In evaluating the critical support(s) rod or strap deadweight hangers shall not be considered as seismic supports in the generic design verification	____	____	__________
3.4	The basis for selection of the critical support shall be documented in the analysis.	____	____	__________
4.0	DUCT SUPPORT PERIODS			
4.1	Duct vertical support periods shall be calculated in accordance with Ref. (2) Section A4.1.	____	____	__________
4.2	Duct horizontal support period shall be calculated in accordance with Ref. (2) Section A4.2.	____	____	__________
4.3	Have all boundary condition assumptions been stated and justified	____	____	__________
4.4	Have all weights been included, duct weight, duct stiffeners, dampers, support members, fireproofing, etc.	____	____	__________
4.5	Has the total weight been increased by 10% to account for miscellaneous items such as bolts, gaskets, air turns, etc.	____	____	__________

HVAC CHECKLIST

By__________Date__________ Page________of________

RLCA Review of Class I HVAC Ducts and Supports

Duct/Support:______________________________________

	Satisfactory		
	Yes	No	Comment
5.0 DUCT PERIOD			
5.1 General Comments - The parameters for calculating duct periods differ for Hosgri and DDE. Duct periods shall be calculated separately for Hosgri and DDE.	____	____	________
5.2 In evaluating the duct period the maximum span between seismic supports shall be used.	____	____	________
5.3 The span between seismic supports shall be obtained from the actual walkdown drawings.	____	____	________
5.4 If design aids were used were they interpreted and applied correctly?	____	____	________
5.5 Generic calculations pertaining to duct periods shall be based on Ref. (2) Section A5.0	____	____	________

HVAC CHECKLIST

By_________Date_________ Page________of________

RLCA Review of Class I HVAC Ducts and Supports

Duct/Support:______________________________________

		Satisfactory Yes	No	Comment
5.6	If the duct's actual span is greater than the maximum span for rigidity the duct period shall be determined as described in Ref. (2) Section A5.0	____	____	________
5.7	Duct period calculations based on Ref. (2) Section A5.0 pertain only to the case where duct mass is uniformly distributed. Ducts with non-uniform mass distribution shall be evaluated on an individual basis.	____	____	________
5.8	In applying Ref. (2) Section A5.0 the following should be noted relative to duct cross-sectional properties:			
5.8.1	For round ducts the entire cross-section may be considered effective.	____	____	________
5.8.2	For DDE rectangular ducts, the entire cross-section may be considered effective.	____	____	________
5.8.3	For Hosgri rectangular ducts, only the stiffened portions of the duct corners shall be considered effective as described in Ref. (2) Section A5.0a	____	____	________

HVAC CHECKLIST

By__________Date__________ Page_________of_________

RLCA Review of Class I HVAC Ducts and Supports

Duct/Support:____

		Satisfactory Yes	No	Comment
5.9	Have the concerns in Section 4.3 through 4.5 of this report been met for the duct period calculations.	____	____	________
5.10	For concentrated masses has the load been applied and/or distributed in an acceptable manner.	____	____	________
5.11	Has the maximum span been assumed to act on both sides of the support under evaluation?	____	____	________
6.0	<u>SYSTEM PERIOD</u>			
6.1	This section deals with the dynamic interaction between the duct and duct supports. Since the duct period differs for Hosgri and DDE cases, then separate system periods must be calculated for each situation.	____	____	________
6.2	In determining the system period the maximum span between supports shall be considered acting on both sides of the support under evaluation (for non-cantilevered supports).	____	____	________
6.3	The system period shall be determined based on Ref (2) Section A6.0	____	____	________

HVAC CHECKLIST

By__________Date__________ Page________of________

RLCA Review of Class I HVAC Ducts and Supports

Duct/Support:____

		Satisfactory		
		Yes	No	Comment
7.0	SEISMIC ACCELERATIONS			
7.1	In general the procedure described in Ref. (2) Section A7.0 shall be used in calculating the Hosgri and DDE seismic accelerations.			
7.2	The Hosgri accelerations shall be determined from the response spectra contained in Ref (3) DCM C-17.	____	____	________
7.3	Damping value for Hosgri shall be 7%.	____	____	________
7.4	The DDE accelerations shall be determined from the response spectra contained in Ref. (4) DCM C-30.	____	____	________
7.5	Damping value for DDE shall be 2%.	____	____	________
7.6	The highest acceleration from either the Blume or Newmark spectra shall be used in the duct and support evaluation for Hosgri.	____	____	________
7.7	The acceleration taken from the response spectra shall be the highest acceleration at or below the calculated system period.	____	____	________
7.8	The spectra that was generated at a point closest to the support under consideration shall be used, interpolation is permisible per Ref (3) and (4).	____	____	________
7.9	Supports at or below elevation 85' shall use ground spectra for the appropriate building.	____	____	________

HVAC CHECKLIST

By__________ Date__________ Page__________ of__________

RLCA Review of Class I HVAC Ducts and Supports

Duct/Support:______________________________

	Satisfactory Yes	Satisfactory No	Comment
7.10 For horizontal spectra both the North-South and East-West directions shall be considered.			
7.11 Has the torsional component of acceleration been considered?			
7.12 For vertical accelerations has 1.0g been added for dead weight considerations?			
8.0 LOADING CONDITIONS			
8.1 The following loads shall be considered in the design verification analysis:			
8.1.1 Deadweight loads (D) Weight of duct, supports, stiffeners, and any other permanent loads.			
8.1.2 Pressure Loads (Pm) Maximum operating pressure for ducts, assumed to be negative.			
8.1.3 Seismic Loads (E') Loads generated from the Hosgri and DDE seismic event.			
8.2 Seismic loads shall be calculated by the 2D-ABSUM or the 3D-SRSS method, see Ref. (3).			
8.3 When using the 2D-ABSUM method, two sets of seismic loads shall be calculated as follows:			

HVAC CHECKLIST

By__________ Date__________ Page__________ of__________

RLCA Review of Class I HVAC Ducts and Supports

Duct/Support:______________________________

	Satisfactory		
	Yes	No	Comment
8.3.1 Set (1): Vertical + Horizontal transverse.	____	____	________
8.3.2 Set (2): Vertical + Horizontal longitudinal.	____	____	________
9.0 LOAD COMBINATIONS			
9.1 Ducts shall be evaluated for the following load combinations: Total Load = D + Pm + E'.	____	____	________
9.2 Duct supports shall be evaluated for the following load combinations: Total Load = D + E'	____	____	________
10.0 DUCT SUPPORT STRESS EVALUATION			
10.1 Stresses (or loads) at each critical location in the duct support members shall be checked against the allowable stresses (or loads) specified in Ref. (1) DCM C-31 Section 6.0.	____	____	________
10.2 Stresses (or loads) at each critical connection in the duct support shall be checked against the allowable stresses (or loads) specified in Section 6.0 of DCM C-31 Ref. (1).	____	____	________
10.3 Are the number of critical members evaluated sufficient?	____	____	________

HVAC CHECKLIST

By_________Date_________ Page________of________

RLCA Review of Class I HVAC Ducts and Supports

Duct/Support:____

	Satisfactory Yes	No	Comment
11.0 DUCT STRESS EVALUATION			
11.1 Seismic and dead load stresses.	____	____	________
11.1.1 Bending and shear stresses shall be calculated in accordance with Ref. (2) Section A11.1.	____	____	________
11.1.2 Axial stress and axial buckling shall be evaluated as described in A11.2 of Ref. (2).	____	____	________
11.2 Pressure stresses in the ducts shall be evaluated in accordance with Section A12.0 of Ref. (2).	____	____	________
11.3 Stresses in the duct sheet shall be evaluated as described in Ref. (2) Section A13.0.	____	____	________
11.4 The duct stiffener stress shall be evaluated as described in Ref. (2) Section A14.0.	____	____	________
12.0 CONCLUSIONS			
12.1 Does the duct meet the requirements of DCM C-31, Ref. (1)?	____	____	________
12.2 Does the duct support meet the requirements of DCM C-31, Ref. (1)?	____	____	________
12.3 Ductwork that does not meet the generic criteria may be reevaluated based on the as-built conditions of each support in the group. When evaluating an individual support, consideration shall be given to the following items:			
12.3.1 Actual duct span.	____	____	________
12.3.2 Response spectra for that specific support location.	____	____	________

HVAC CHECKLIST

By__________Date__________ Page_________of_________

RLCA Review of Class I HVAC Ducts and Supports

Duct/Support:____

	Satisfactory Yes	No	Comment
12.3.3 Actual torsional eccentricity with respect to the building center of mass.	____	____	__________
12.3.4 Actual duct operating pressure.	____	____	__________
12.3.5 Strength of supporting concrete for that specific location.	____	____	__________
12.3.6 For "as-built" condition, dead weight rod and strap hangers may be considered effective if they meet the requirements of DCM C-31, Ref. (1).	____	____	__________
12.4 Ductwork that does not meet the generic or the as-built evaluation shall be modified as required to meet the criteria.	____	____	__________

Appendix A2

Sample Checklists

Instrument Tubing and Supports

(1 page)

INSTRUMENT TUBING SUPPORT CHECKLISTS

	Satisfactory Yes	No	Comment
Is worst case support location shown?	____	____	________
Is worst case support length "L" shown:	____	____	________
Is worst case supported load (tributary) calculated?	____	____	________
Is system natural frequency calculated?	____	____	________
Is natural frequency below 33 Hz?	____	____	________
Is correct hosgri response spectra referenced? (from DCM C-17 Rev. 6)	____	____	________
Is peak spectra acceleration value at 4% damping used?	____	____	________
Is support deadload correct and included in stress calculations?	____	____	________
Are key stress locations considered?	____	____	________
Are DCM M-9 allowables cited?	____	____	________
Are calculated stresses below allowables?	____	____	________
Is analysis sufficiently complete to provide support qualification?	____	____	________

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RLCA

Appendix B

Sample Checklists

Electrical Raceway Supports

Appendix B1

Sample Checklists

Electrical Raceway Supports

Transverse Analyses

(4 pages)

CHECKLIST FOR RACEWAY SUPPORTS

Page ____of____

By________________

	Satisfactory Yes	Satisfactory No	Comment
DESIGN ANALYSIS INPUT			
Is support modeled from as-built or DRW 050030, Revision 29 configuration?	___	___	________
If worst case generic load configuration for a support detail is not analyzed, does as-built case analyzed represent worst-case configuration?	___	___	________
Are sources of information adequately referenced?	___	___	________
Is support deadload correct?	___	___	________
Are raceway and conduit weights as-built or max allowable?	___	___	________
Are all locations of generic S-type identified?	___	___	________
Is as-built information for all support locations included in package?	___	___	________
Is tributary deadweight calculated using max allowable span or greatest as-built span?	___	___	________
SEISMIC RESPONSE CALCULATION			
Are system natural frequencies calculated correctly?	___	___	________
Is the N-S and E-W horizontal spectra computed per DCM C-15, Revision 3 procedure?	___	___	________
Are these accelerations calculated separately for Blume and Newmark spectra and the greater chosen?	___	___	________

By_______________

	Satisfactory Yes	Satisfactory No	Comment
Does calculation use 7% damped response?	___	___	___
Is the vertical response for DDE .36g?	___	___	___
If an as-built calculation, is the spectral ordinate corresponding to the calculated natural period of raceway support used?	___	___	___
If a generic condition is calculated, is the peak spectral value used if the calculated natural period of the raceway is greater than that corresponding to 75% of the peak spectral value?	___	___	___
If more than one set of spectra exist for a floor elevation, is controlling spectra utilized for analysis?	___	___	___
Is ground response spectra used if the support is at elevation 85 feet or below?	___	___	___
QUALIFICATION PROCEDURES AND CRITERIA			
Are maximum horizontal, vertical, and support deadweight loads combined by ABS for critical locations?	___	___	___
Is the acceptance criteria for cold-formed steel members as specified in DCM C-15, Revision 3 followed? (F_b, F_v, F_t)	___	___	___
Does calculation for axial compression meet DCM C-15, Revision 3 guidelines?	___	___	___

By____________	Satisfactory Yes	Satisfactory No	Comment
If axial and flexural stresses occur simultaneously in a cold-formed steel member, is the interaction formula of DCM C-15, Revision 3 applied?	___	___	______________
Are allowable loads on Unistrut (or equivalent) concrete inserts, channel connection, and bolts used in accordance with DCM C-15, Revision 3?	___	___	______________
For combined pullout and slip on Unistrut (or equivalent) concrete inserts, channel connections and bolts, is the interaction formula DCM C-15, Revision 3 used?	___	___	______________
Are allowable loads on Unistrut (or equivalent) pipe clamps those values in Table B of DCM C-15, Revision 3?	___	___	______________
Are allowable loads on concrete expansion anchors those given on PGandE Drawing 054162, Revision 3?	___	___	______________
Is calculation of pullout and shear loads on concrete expansion anchors calculated per PGandE Drawing 054162, Revision 3?	___	___	______________
Are unbraced joints made of angle fittings checked using Attachments G and H of DCM C-15, Revision 3?	___	___	______________

By______________	Satisfactory		Comment
	Yes	No	
ANALYSIS ASSUMPTIONS AND CONCLUSIONS			
Are calculation assumptions valid?	___	___	______________
Are analysis conclusions valid and consistent with calculation results?	___	___	______________

Appendix B2

Sample Checklists

Electrical Raceway Supports

Longitudinal Analyses

(4 pages)

CHECKLIST FOR RACEWAY SUPPORTS
LONGITUDINAL DIRECTION

Page ___of___

By______________

	Satisfactory		Comment
	Yes	No	
DESIGN ANALYSIS INPUT			
Is support modeled from as-built or DRW 050030, Revision 29 configuration?	___	___	__________
Are sources of information adequately referenced?	___	___	__________
Is support deadload correct?	___	___	__________
Are raceway and conduit weights as-built or max allowable?	___	___	__________
Is as-built information for all support locations included in package?	___	___	__________
Is tributary deadweight calculated using max allowable span or greatest as-built span?	___	___	__________
SEISMIC RESPONSE CALCULATION			
Are support stiffnesses calculated correctly?	___	___	__________
Are system natural frequencies calculated correctly?	___	___	__________
Is the N-S and E-W horizontal spectra computed per DCM C-15, Revision 3 procedure?	___	___	__________
Are these accelerations calculated separately for Blume and Newmark spectra and the greater chosen?	___	___	__________

By_____________

	Satisfactory Yes	Satisfactory No	Comment
Does calculation use 7% damped response?	___	___	___
Is the vertical response for DDE .36g?	___	___	___
If an as-built calculation, is the spectral ordinate corresponding to the calculated natural period of raceway support used?	___	___	___
If more than one set of spectra exist for a floor elevation, is controlling spectra utilized for analysis?	___	___	___
Is ground response spectra used if the support is at elevation 85 feet or below?	___	___	___
QUALIFICATION PROCEDURES AND CRITERIA			
Are maximum horizontal, vertical, and support deadweight loads combined by ABS for critical locations?	___	___	___
Is the acceptance criteria for cold-formed steel members as specified in DCM C-15, Revision 3 followed? (F_b, F_v, F_t)	___	___	___
Does calculation for axial compression meet DCM C-15, Revision 3 guidelines?	___	___	___
Are diagonal braces adequate in compression?	___	___	___

By______________

	Satisfactory Yes	Satisfactory No	Comment
If axial and flexural stresses occur simultaneously in a cold-formed steel member, is the interaction formula of DCM C-15, Revision 3 applied?	___	___	___________
Are allowable loads on Unistrut (or equivalent) concrete inserts, channel connection, and bolts used in accordance with DCM C-15, Revision 3?	___	___	___________
For combined pullout and slip on Unistrut (or equivalent) concrete inserts, channel connections and bolts, is the interaction formula DCM C-15, Revision 3 used?	___	___	___________
Are allowable loads on Unistrut (or equivalent) pipe clamps those values in Table B of DCM C-15, Revision 3?	___	___	___________
Are allowable loads on concrete expansion anchors those given on PGandE Drawing 054162, Revision 3?	___	___	___________
Is calculation of pullout and shear loads on concrete expansion anchors calculated per PGandE Drawing 054162, Revision 3?	___	___	___________
Are unbraced joints made of angle fittings checked using Attachments G and H of DCM C-15, Revision 3?	___	___	___________

By_____________

	Satisfactory Yes	Satisfactory No	Comment
ANALYSIS ASSUMPTIONS AND CONCLUSIONS			
Are calculation assumptions valid?	___	___	_______________
Is analysis complete and methodology acceptable?	___	___	_______________
Are analysis conclusions valid and consistent with calculation results?	___	___	_______________

Appendix C

EOI Reports

(2 pages)

EOI Status
HVAC Ducts, Electrical Raceways, Instrument Tubing and Associated Supports
Corrective Action

EOI File No.	Subject	Rev.	Date	By	Type	Action Required	Physical Mod.
983	Raceway - Installation, Criteria and Input Concerns	0	2/6/82	RLCA	OIR	RLCA	
		1	4/21/82	TES	ER/A	PGandE	
		2	9/10/82	TES	ER/A	PGandE	
		3	8/12/83	TES	OIR	RLCA	
		4	8/22/83	RLCA	PPRR/CI	TES	
		5	8/22/83	TES	PRR/CI	TES	
		6	8/22/83	TES	CR	NONE	Yes
1003	HVAC Ducts and Supports - Criteria and Procedures	0	2/6/82	RLCA	OIR	RLCA	
		1	6/7/82	RLCA	PPRR/OIP	TES	
		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	
		6	7/21/83	TES	OIR	RLCA	
		7	7/22/83	RLCA	PPRR/CI	TES	
		8	8/1/83	TES	PRR/CI	TES	
		9	8/1/83	TES	CR	NONE	Yes

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.

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HVAC Ducts, Electrical Raceways, Instrument Tubing and Associated Supports

Corrective Action (Continued)

EOI File No.	Subject	Rev.	Date	By	Type	Action Required	Physical Mod.
1123	ITS-5; Difference between as-built and analyzed member size	0	5/13/83	RLCA	OIR/OIP	PGandE	
		1	6/23/83	RLCA	PER/C	TES	
		2	6/27/83	TES	ER/C	PGandE	No
		3	7/13/83	TES	CR	None	
1134	HVAC Duct Frequencies - application of Rayleigh-Ritz method	0	6/15/83	RLCA	OIR	RLCA	
		1	8/22/83	RLCA	PPRR/CI	TES	
		2	8/22/83	TES	PRR/CI	TES	
		3	8/22/83	TES	CR	NONE	No
1143	HVAC Duct Analysis HV-88, application of seismic inputs	0	8/16/83	RLCA	OIR/OIP	PGandE	

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 D

Program Manager's Assessment

(1 page)

PROGRAM MANAGER'S ASSESSMENT

As IDVP Program Manager, TELEDYNE ENGINEERING SERVICES(TES) has established a Review and Evaluation Team, directed by a qualified team leader as described in Section 7.4(c) of the IDVP Phase I Program Management Plan.

This Team has reviewed RLCA Preliminary and Final Design Reviews associated with IDVP verification of the DCP Corrective Action Program for Electrical Raceways and Supports, HVAC Ducts and Supports, and Instrument Tubing and Supports, as described in Status Reports to the TES Project Manager; and has provided comments, thereon, to RLCA for consideration for incorporation into such Design Reviews. In addition, members of the Team have accompanied RLCA personnel during data-gathering activities performed at the Diablo Canyon Plant.

The Team Leader and the TES Program Management Team, based upon verification completed to date, have concurred with the Conclusions presented in Section 8.0 of this Interim Technical Report No. 63.