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PRELIMINARY REPORT,

SEISMIC REVERIFICATION PROGRAM

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Project 105-4

Report of work performed for Pacific Gas & Electric Co. by R. L. Cloud Associates, Inc.

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A PRELIMINARY REPORT ON THE DESIGN INTERFACE REVIEW OF THE SEISMIC REVERIFICATION PROGRAM

1.0 Introduction

As a result of the discovery of a misapplication of seismic floor spectra to the annulus area of the Diablo Canyon Power Plant Unit 1, a Seismic Reverification Program was established to determine if further errors exist in seismic qualification of the plant for the Hosgri 7.5 M earthquake. This program was presented verbally to the U. S. Nuclear Regulatory Commission in a meeting at Bethesda, Maryland on October 9, 1981. The NRC felt the program was useful, but requested a preliminary report on part of Task 3 of the Reverification Program on a priority basis. This program was then expanded to include Tasks 1 and 2 insofar as they relate to the design information flow and seismic qualification of structures and equipment.

Task 3 of the original program is titled "Design Interface Review" and consists of a review of seismic design and qualification information that was transmitted back and forth between PGandE and subcontractors during the evaluation of the plant for the Hosgri earthquake. The part of Task 3 requested in an early preliminary report was a review of the particular design interface that existed between PGandE and URS/Blume during the Hosgri re-evaluation.

Task 1 of the original program is titled "Study of Qualification Based on Symmetry" and consists of examining the flow

of information used in qualifying the Diablo Canyon Unit 1 safety related structures and equipment. This effort will encompass that work based on opposite hand application or other symmetry conditions. In a parallel effort, Task 2, "Review of Steps in the Seismic Design Process" will be addressed by defining and examining the design process. This includes some reviewing of information flow internal to both PGandE and URS/Blume.

This report has been prepared in response to the NRC request for a preliminary report on the URS/Blume - PGandE Seismic Design Interface. The cut-off date for the preliminary review of all building, structures and equipment except heating, ventilation and air conditioning (HVAC) components and ducting is October 28, 1981. For the HVAC components and ducting, the cut-off date is November 2, 1981. Any omissions of significant information or other incompleteness will be addressed in the overall reverification program.

Through out the report references are made to logs. This log information is maintained in the form of log books which are available for authorized examination at the office of Robert L. Cloud Associates.

2.0 Objective and Scope

The objective of the original Seismic Reverification Program* was to consider the following three tasks:

Task 1.0: Study of qualification based on symmetry

Ensure that all work applied to Diablo Canyon Power Plant (DCPP) Unit 1 that is based on opposite hand application or other symmetry conditions is correctly applied.

Task 2.0: Review of steps in the seismic design process

Chart the seismic design process for the DCPP and review the steps in the process or the links in the seismic design chain.

Task 3.0: Design Interface Review

Review the applicability of seismic qualification work passing between PGandE and subcontractors. The objective of this task is to review the applicability of design information that passes across design interfaces.

For Task 1.0 all seismic qualification of safety related buildings and equipment that has been performed only one time, but is applied to both Units of DCPP by utilization of opposite hand or other symmetry shall be reviewed. Qualification documents take the form of stress reports, design evaluation reports, data sheets, test reports, and certification reports.

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* "Seismic Reverification Program", Robert L. Cloud Associates, Inc., Berkeley, CA, October 12, 1981.

For Task 2.0, the flow of the seismic design process shall be reviewed. The flow begins with approved Hosgri earthquake ground motion and ends with a qualification document.

The scope of the present effort for Task 3.0 is limited to the review of the design interface of PGandE with URS/Blume, specifically for the three categories:

(1) that transmitted from PGandE to URS/Blume
(2) that transmitted from URS/Blume to PGandE
(3) that received from URS/Blume by PGandE and subsequently distributed, by PGandE, to those qualifying components or systems

The overall requirement was to perform an engineering review of this information in a selective manner, as described in Section 3.0. The information was reviewed to establish that correct building and equipment configurations were transmitted for analysis; that analysis was performed using applicable drawings with the correct revision, applicable equipment weights, etc.

Design spectra, building loads and other output of URS/Blume as transmitted by URS/Blume and received by PGandE were scheduled for examination with the objective of checking to see that URS/Blume-generated information was properly applied. The buildings and equipment reviewed in the present effort are those required for safe cold shutdown, and were requalified in the Hosgri reanalysis.

3.0 Program Methodology

The program tasks as defined in Section 2.0 will be addressed through the following process:

a) Definition of Seismic Qualification Interfaces
b) List Categories of Information Flow through Interface
c) Review Interface Design Information Flow for Structures
d) Review Interface Design Information Flow for Equipment

Task 3.0, the Design Interface Review, is directly addressed through the format of the above methodology. Tasks 1.0 and 2.0 are also addressed although somewhat indirectly. Task 1.0, the Study of Qualification Based on Symmetry, is accomplished by examining the seismic qualification of cold shutdown required safety related structures and equipment. This examination consists primarily of reviewing the seismic qualifications for applicable seismic inputs. Task 2.0, Review of Steps in the Seismic Design Process, is addressed by tracing the flow of design information through PGandE and their subcontractors. Although this report deals primarily with PGandE and URS/Blume information flow, substantial work was performed to examine the flow within PGandE.

The methodology process is described in the following subsections.

3.1 Definition of Seismic Qualification Interfaces

The seismic qualification interfaces of interest for the present effort are illustrated in Figure 3.1. As can be seen, there are three primary interfaces that are denoted by Roman Numerals. The work interface refers to the process or activity in which certain engineering work is done in one organization, then transmitted to another. In the receiving organization, the engineering work is used, and perhaps transformed or reduced, and transmitted on to other organizations.

Referring to Figure 3.1, the three primary interfaces are:

I. Development and assembly of structural configurations, equipment locations and masses, together with the geologic and seismologic description of the Hosgri earthquake. This basic plant engineering description and earthquake description are forwarded to URS/Blume for dynamic analysis.

II. URS/Blume receives the plant configuration description. From this information, URS/Blume develops ground response spectra and analytical models of the civil structures, and performs the dynamic analysis of the structures to determine their response to the Hosgri earthquake. This response, in the form of amplified floor response spectra and building loads or building analysis reports, is then transmitted to PGandE.

III. PGandE receives the civil/structural seismic response information and organizes and/or reduces it into suitable forms for transmittal to third parties for use in evaluating equipment, and in some cases, buildings. Equipment as used here refers to everything in the plant other than civil structures.

Figure 3.1, illustrating the interfaces, has additional flow paths that indicate feedback loops across the interfaces and dashed lines that indicate possible indirect interfaces. These additional communication paths are listed to complete all possible interface interaction activity.

3.2 Review Methodology

It was convenient to develop an organized approach to the review to minimize confusion, lost motion, and to ensure that a complete review was accomplished. The following paragraphs describe the methodology that was devised for use in the current preliminary effort.

The basic orientation of the review was to ensure that the applicable design and qualification information was used for building and equipment qualification by studying the engineering work itself. Although casual observations were made on QA/QC type questions such as independent checking, following of procedures, etc., the basic intent of the present effort was to determine if the applicable engineering data was used in the seismic qualification calculations, regardless of the formality with which it was handled.

A second tenet of this effort was to perform a review that was both broad and complete, but also had the requisite depth. In order to accomplish this objective, two goals were set. The first goal was to examine all the interface design information involving URS-Blume to verify consistency and general accuracy. The second goal was to review all the interface information involving URS/Blume for two selected buildings in complete and comprehensive detail. The two buildings selected were the Intake Structure and the Containment Building.

3.2.1 Listing

Having defined the design interfaces, the next step was to list the categories of information expected to flow across each of the 3 interfaces. These categories are listed in Figure 3.2.

3.2.2 Structures

To break the required information into more manageable packages, the design information was examined separately for each building. The buildings are listed in Figure 3.2.2-1 with cognizant responsibilities for major tasks. There was a separate responsible PGandE building engineer for each structure.

The interface design information was studied separately for each building and is reported separately.

3.2.3 Equipment

Although the overall cognizant responsibility for the Hosgri requalification of equipment was PGandE scope, the analysis effort was divided between PGandE and Westinghouse, as listed in Figure 3.2.3-1. PGandE performed this qualification in-house with PGandE engineers in some cases, and utilized subcontractors for others. Subcontractor interfaces on equipment qualification are described in the body of this report.

The general strategy regarding equipment qualification was straight forward. The flow of design spectra was traced from the URS/Blume report on the relevant building to the qualification document for the individual items or classes of safety related equipment. For this preliminary report, some of the specific seismic input for certain types of equipment required more time to track than was available. When this occurred it is noted and the input will be reviewed in the overall report.

A sizeable portion of Hosgri required equipment was evaluated by Westinghouse. The flow of seismic design information sent to Westinghouse by PGandE was documented (See Log 3.1.1).

The Intake Structure Hosgri spectra were sent to Westinghouse on April 15, 1977. These spectra are identical to the current Hosgri spectra, through Ammendment 83. The Auxiliary Building Hosgri spectra and control room slab update, April 11, 1977 and March 25, 1980 respectively are also identical to the current Hosgri spectra, through Ammendment 83.

The spectra for the Exterior and Interior Containment Structure were respectively transmitted to Westinghouse on March 16 and 23, 1977. The Exterior Containment spectra were superseded by the URS/Blume report issued on June 5, 1977. However, no transmittal to Westinghouse of this spectra could be located in the PGandE files. On August 9, 1977, PGandE transmitted vertical spectra for the Containment Structure to Westinghouse.

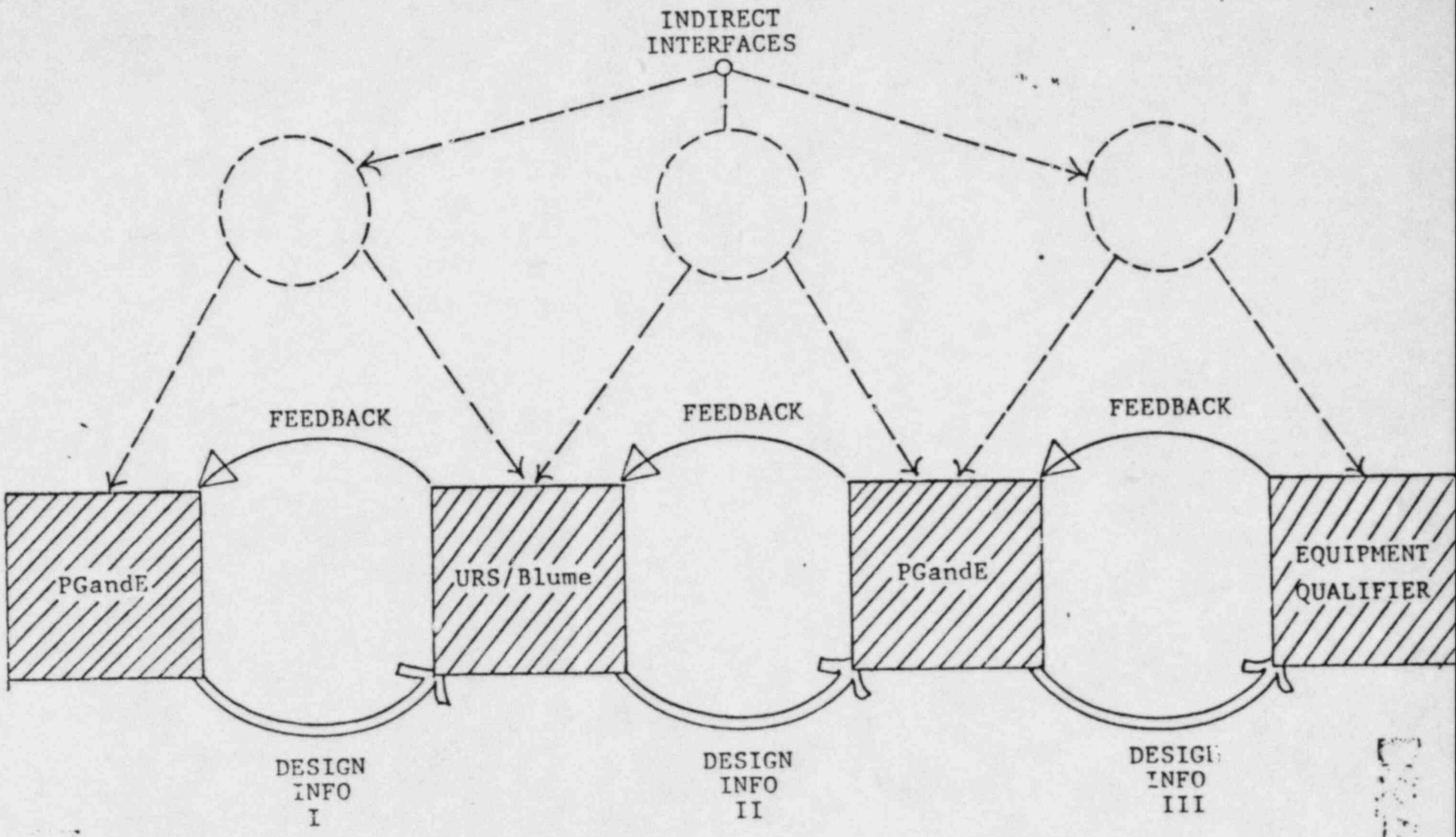

FIGURE 3.1: SEISMIC QUALIFICATION INTERFACES

Interface I	Interface II	Interface III
Building Drawings Equipment Weights and C. G. Documentation of Verbal Discussion Seismologic and Geologic Definition of Ground Motion	Floor Response Spectra for all locations throughout plant Building Loads Dynamic Analysis Reports for all Buildings	Envelope Floor Spectra Static g Loads Equipment Specifications Test Specifications Purchase Orders

FIGURE 3.2 INFORMATION CATEGORIES OF INTERFACE

	INTAKE BUILDING	CONTAINMENT BUILDING	AUXILIARY BUILDING	TURBINE BUILDING	CRANES	FIELD ERECTED TANKS
MODELING & DYNAMIC ANALYSIS	URS/Blume	URS/Blume	PGandE, URS/Blume	URS/Blume	W* - 3 URS/B - 4	URS/Blume
DEVELOP SPECTRA	Not Required	URS/Blume	URS/Blume	URS/Blume	URS/Blume**	Not Required
SEISMIC QUALIFICATIONS ANALYSIS	URS/Blume	PGandE	PGandE	URS/Blume	W - 3 URS/B - 4	URS/Blume

* Westinghouse

** For Polar Crane only

Diablo Canyon Nuclear Power Plant Unit 1

SEISMIC QUALIFICATION ANALYSIS OF BUILDINGS

COGNIZANT RESPONSIBILITIES

Figure 3.2.2-1

EQUIPMENT	ANALYSIS BY
Reactor Coolant System and Equipment	W*
Piping Systems 6" and over connected to Reactor Coolant System	W
Piping, Primary and Secondary Systems	PGandE & Subcontractors
Safety Related Conduit & Raceways	PGandE
Safety Related Mechanical Equipment	PGandE
HVAC	PGandE
Instrumentation and Control Equipment	PGandE

* Westinghouse

FIGURE 3.2.3-1 SUMMARY OF EQUIPMENT QUALIFICATION ANALYSIS

3.3 Review of Structures and Equipment

The review of design chain, opposite hand symmetry and interface information for structures and equipment was performed using the methodology described in Section 3.2. To break the required information into more manageable packages, the design information was examined for the following categories:

1. Containment Structure
2. Intake Structure
3. Turbine Building
4. Auxiliary/Fuel Handling Building
5. Cranes
6. Outdoor Water Storage Tanks
7. General Equipment and Systems

The Containment and Intake Structures were given a higher priority. Thus, these were reviewed in more depth. Sections 3.3.1 through 3.3.7 discuss in detail the design information reviewed for the above-mentioned categories.

3.3.1 Containment Structure

The Containment Structure was originally analyzed for the Double Design Earthquake (DDE) by URS/Blume. Results of this analysis are given in the URS/Blume report dated July 1970, "Diablo Canyon Nuclear Power Plant, Unit No. 1, Containment Structure - Finite Element Method Dynamic Seismic Analysis", (Reference 1). To comply with the 7.5 M Hosgri specification, the Containment Structure was re-analyzed. This re-analysis is presented in the URS/Blume report, "Diablo Canyon Nuclear Power Plant, Unit 1, Containment Structure Dynamic Seismic Analysis for the 7.5 M Hosgri Earthquake", May 1979 (Reference 11).

The design chain and the opposite hand symmetry are discussed in the following sections, which describe the transfer of information between PGandE and URS/Blume for the Containment Structure and five major pieces of equipment. Auxiliary equipment, such as cranes, piping, heating, ventilating and air conditioning, etc. are covered in Section 3.3.5 through Section 3.3.7.

3.3.1.1 Design Information from PGandE to URS/Blume

The close and informal relationship between PGandE and URS/Blume engineers resulted in sparse documentation of design information, drawings, equipment weights, pipe loads, etc. from PGandE to URS/Blume. Appendix 1.1 contains the transmittal documentation obtained from PGandE for the period 1969 through 1981 for the Containment Structure. The documentation in Log 1.1 was obtained from Central Files in the Mechanical Engineering Department (Log 5) and the Civil Engineering Department (Log 4) and various personal files of engineers at PGandE. In addition, part of the information was obtained from URS/Blume's project file. The informal interface between PGandE and URS/Blume as recollected by the PGandE engineer responsible for the Containment is contained in Log 1.1, Item #16.

For the Hosgri re-evaluation (Reference 11) the dynamic model for the horizontal direction was the same as for the double design earthquake (DDE) analysis (Reference 1) with additional consideration of torsion. For the vertical response the annulus was modeled using additional annulus information provided by PGandE and field visits (Log 1.1, Item #16).

To verify that the documents used by URS/Blume to develop the original dynamic model (used subsequently for the Hosgri re-evaluation) were correct, a list of drawings was checked. This list, given in Log 1.1, Item #14, was obtained from the July 1970 report on the Containment Structure (Reference 1). A review of the above-mentioned drawings was performed to check that the referenced drawings:

- were Containment Structure - Unit 1 drawings, and
- when the drawings had revisions dated later than July 1970, these were so noted in the field work (Log 1.1, Item #14).

It was found that revisions made after 1970 were minor (Log 1.1, Item #14), and do not affect the model in the horizontal direction.

In the case of the annulus, the only drawing documentation available are the four sketches sent to URS/Blume from PGandE (Log 1.1, Item #5), and the calculation sketch at URS/Blume (Log 1.1, Item #17). These sketches are for Unit 2 annulus and not for Unit 1. Unit 2 drawings, as provided by PGandE, were used by URS/Blume to formulate the seismic model because they were clearer and more easily read.

As a result, the dynamic model in the Hosgri re-evaluation report (Reference 11) was a composite of Unit 1 interior and exterior structures and a Unit 2 annulus structure. Therefore, the five conceptual frames shown in the sketches are correct for both Units 1 and 2 except in their circular orientation. The frame orientation sketch used to

locate the spectra was correct for Unit 2 but was incorrect for Unit 1.

The computed floor response spectra corresponding to the particular frame location and elevation in the annulus are used to determine vertical seismic inputs for the seismic qualification of systems and equipment supported by the annulus structural steel at that location.

Because the annulus layouts of Units 1 and 2 have an opposite hand relationship and the vertical spectra are dependent on polar orientation, certain systems and equipment were analyzed using inappropriate spectra. The orientation error resulted in the use of vertical spectra for Unit 1 evaluation that are in some cases lower, and in other cases higher than those that should have been used. It should be noted however, that items qualified using Frame 3 spectra are not affected by the orientation error because this frame has identical locations in Unit 1 and Unit 2.

3.3.1.2 Design Information from URS/Blume to PGandE

Unlike the sparse transmittal documentation from PGandE to URS/Blume, the documentation from URS/Blume to PG andE was relatively complete. This is verified by reviewing the transmittal documents listed in Log 2.1.1. This Log contains transmittal documents sent to PGandE from February 1977 to present. These documents were obtained from URS/Blume during the week of October 13, 1981. The contents of the transmittal documents marked with an asterisk are in Log 2.1.2.

3.3.1.3 Design Information from PGandE to Equipment Suppliers and Qualifiers

For the purpose of this interface review, the seismic input information for the following equipment was evaluated:

1. Reactor Coolant System
2. Hydrogen Recombiner
3. Containment Purge Valves
4. Regenerative Heat Exchanger
5. Containment Fan Coolers

It was found that most of the design information for the above equipment was transmitted to Westinghouse (Log 3.1). The accuracy of this information is discussed in the next section.

3.3.1.4 Qualification of Containment Structure and Equipment

3.3.1.4.1 Containment Structure

A comprehensive design review of the Containment Structure was originally completed on 2/28/77. This review had one outstanding item - pipe rupture restraints. This item was cleared, and an amendment was issued on 1/16/78. The original review and the amendment were performed by PGandE and are given in Log 7.

Another design review of the Containment Structure was completed by PGandE on 1/22/79. This design review addressed the structural adequacy of the Containment Structure for the postulated 7.5 M Hosgri seismic event (Log 2.1).

To check the use of correct seismic inputs for the Containment Structure qualification, Two class I platforms in Containment were chosen at random. The Hosgri seismic accelerations used to qualify these platforms were found to be correct (Log 7).

Because of the recent developments in the annulus area, PGandE is presently re-evaluating the structural adequacy of the annulus.

3.3.1.4.2 Equipment

A detailed review of equipment is given in Log 3.1. A summary is given below:

1. Reactor Coolant System
   Westinghouse (W) seismically analyzed the Reactor Coolant System for the Hosgri Requirement as discussed in the W report, "Summary Report, Seismic Evaluation of Westinghouse Equipment for Postulated 7.5 M Hosgri Earthquake, Diablo Canyon Units 1 and 2", August 1979 (Log 3.1.2). The seismic spectra used for analysis envelope the current Hosgri spectra for the interior concrete, and thus the seismic qualification is valid.

2. Hydrogen Recombiner
   Westinghouse (W) originally analyzed the Hydrogen Recombiner in the annulus region by test. These were transmitted to PGandE as discussed in Log 3.1.2. Due to the conservative nature of the test spectra utilized in the original analyses, it was confirmed that the Hydrogen Re-combiners qualify to the new enveloped annulus spectra.

3. Containment Purge Valves
The Containment Purge Valves were qualified by T. N. Crawford as stated in the memo-to-file dated 6/11/79 (Log 3.1.2). The accelerations used in analysis were reviewed, and are more conservative than the current Hosgri spectra.

4. Regenerative Heat Exchangers
Westinghouse (W) performed the seismic analysis of the Regenerative Heat Exchangers.

Examination of the information in the W report, "Summary Report, Seismic Evaluation of Westinghouse Equipment for Postulated 7.5 M Hosgri Earthquake", shows that the correct free field, tau filtered horizontal response spectrum was used in the qualification analysis.

For the vertical direction, the W report states that two-thirds of the filtered horizontal spectrum was used in the analysis. However, the Hosgri report states that two-thirds of the unfiltered horizontal response spectra is to be used as the response spectra for the vertical direction (Reference 6, page 4-3). The vertical spectra input used by Westinghouse is in error.

A safety factor of 1.0 currently exists for the as-performed Westinghouse analysis. Use of the unfiltered spectrum in the vertical input would increase the vertical load by approximately 15% and invalidate the seismic qualifi-

cation (see Log 3.1).

5. Containment Fan Coolers
   A detailed discussion of the qualification and review process for the containment fan coolers is given in Log 3.1.2. The end result of this check shows that superseded spectra were utilized for qualification. PGandE addressed this fact in May 1973 (Log 3.1.2). In this particular case, the conclusions are still valid because the spectra that were used envelope the current spectra.

Besides the equipment reviewed above, other equipment in the Containment Structure has not been reviewed for the current effort, but will be done in the Reverification Program.

3.3.2 Intake Structure

The Intake Structure, which serves both Units 1 and 2, is a seismic Class II structure. However, because it houses the four Class I auxiliary saltwater pumps, two for each unit, it was reviewed by URS/Blume for the postulated 7.5 M Hosgri motions. Except for the auxiliary saltwater pumps, safe shutdown in the event of a major earthquake disturbance is not considered essential for any part of the structure or its four main circulating water pumps.

3.3.2.1 Design Information from PGandE to URS/Blume

PGandE's Civil Engineering file was searched for the design information transmitted from PGandE to URS/Blume on the Intake Structure during and prior to the Hosgri studies (Log 4). No such information was found. The following information was taken from the file of the responsible PGandE engineer for the Intake Structure.

The seismic analysis of the Intake Structure for the Hosgri criteria was initiated on April 26, 1976 (Log 1.2). The relevant information such as civil/mechanical drawings, equipment weights and soil information were found to be transmitted from PGandE to URS/Blume from April 26 to June 22, 1976 (Log 1.2).

3.3.2.2 Design Information from URS/Blume to PGandE

A two-phase work scope of the seismic analysis of the Intake Structure for the Hosgri criteria was found in a memorandum dated 5/6/76 from URS/Blume

to PGandE (Log 2.2.1). Some weekly progress reports from URS/Blume were found in the PGandE civil engineering file (Log 4).

A preliminary report on the seismic analysis of the Intake Structure was issued by URS/Blume to PGandE on April 6, 1977. Modifications of this report were made on 5/9/77 and 2/14/78, and the final report was issued on 5/16/79. An additional report entitled "Diablo Canyon Intake Structure-Factor of Safety Against Overturning, Foundation Bearing Pressures", was issued on 11/13/78 (see Log 2.2.2).

The design drawings used by URS/Blume to develop the mathemetical model for the seismic analysis were reported in "DCNPP - Intake Structure Dynamic Seismic Analysis for the 7.5 M Hosgri Criteria", May 9, 1977 (See Log 2.2.2). These drawings were compared with the Intake Structure drawings in the PGandE file (Log 1.2). A list of Intake Structure drawings currently in URS/Blume files is also given in Log 1.2. It was found by comparing a few of the drawings used in developing the mathematical model of the Intake Structure with those in the PGandE file, that the revisions are minor and shall not affect the mathematical model used in the seismic analysis.

3.3.2.3 Design Information from PGandE to Equipment Suppliers and Qualifiers

Because the Auxiliary Salt Water Pumps are the only major equipment of the Intake Structure which were qualified by PGandE using the site design spectra, no design information to equipment suppliers and qualifiers was required.

3.3.2.4 Qualification of Intake Structure and Equipment

3.3.2.4.1 Intake Structure

According to the lead PGandE engineer responsible for the Intake Structure, the building was qualified by using seismic response output produced in the URS/Blume 5/9/77 report (Log 1.2). The URS/Blume 5/16/79 report gave smaller building response. Therefore, the building does not need to be re-qualified. The design review of the Intake Structure for the Hosgri event was performed by URS/Blume in April 1979 and verified by PGandE in May 1979 (Log 7). The design review for the auxiliary salt-water pump compartments was dated September 1976 (Log 7). It was later qualified for Hosgri as a part of the Intake Structure. However, no formal documentation has been found to date.

3.3.2.4.2 Auxiliary Salt Water Pumps

The safety-related Class 1 equipment inside the Intake Structure are the auxiliary salt water pumps. They were qualified by PGandE using the site design spectra (Hosgri criteria, see Log 2.2) based on the reason that the building is essentially rigid. Although the 5/9/77 and 5/16/79 reports by URS/Blume differ in seismic structural responses, there is no need to requalify the auxiliary salt water

pumps if the building is truly rigid. The rigidity of the building is documented in the URS/Blume report (May 1979, Revised).

3.3.2.4.3 Buried Pipelines

The buried pipelines connecting the Intake Structure to the Turbine Building were qualified by PGandE with input from URS/Blume. PGandE's qualification work was independently checked by Harding-Lawson Associates, using input from URS/Blume (See Log 7). The input used in the above two studies will be verified in the overall reverification program.

3.3.3 Turbine Building

The Turbine Building was originally designated a seismic Design Class II structure and designed on the basis of a minimum horizontal seismic coefficient of 0.2.g. The structure was later analyzed for the double design earthquake (DDE) and was found to require minor structural modification. This is presented in the URS/Blume report, "Diablo Canyon Nuclear Power Plant, Earthquake Analysis Turbine Building, Unit 1", dated July, 1970 (Reference 2).

Because the building contains some design Class I equipment and because it is in close proximity to the Class I Auxiliary Building, it was necessary to show that under the postulated 7.5 M Hosgri motions the building would not have a failure which would impair either the Class I equipment contained in the Turbine Building or the Class I Auxiliary Building. For this reason, the Turbine Building was investigated for the Hosgri inputs. This resulted in major structural modifications, which are given in the URS/Blume report, "Diablo Canyon Nuclear Power Plant, Unit 1, Turbine Building Evaluation and Structural Modification for the 7.5 M. Hosgri Earthquake", March, 1980 (Reference 3).

The following sections address the interface issue between PG andE, URS/Blume,and Equipment Suppliers and Consultants for the Turbine Building.

3.3.3.1 Design Information from PGandE to URS/Blume

The original design and analysis, including the generation of drawings of the Turbine Building, were done by URS/Blume. Following the Hosgri requirement to re-evaluate the Turbine Building in 1977, URS/Blume performed the analysis and re-evaluation. Design changes and drawings were

generated by PGandE from URS/Blume input. These were then checked and verified by URS/Blume. (This is documented in Section 4, Log 1.3)

In the case of the Turbine Building, a large number of transmittals were documented. Log 1.3 contains transmittal documentation for the period 1974 to 1979. Relevant design information transmitted is given in Log 1.3.

3.3.3.2 Design Information from URS/Blume to PGandE

Log 2.3.1 contains transmittal documents from URS/Blume to PGandE. They reference various spectra, design, analysis and test reports and other correspondence of technical nature.

The detail transmittals themselves have not been reviewed. This will be a part of the overall reverification work.

3.3.3.3 Design Information from PGandE to Equipment Suppliers and Qualifiers

In the Turbine Building, the major safety related mechanical equipment systems are the Diesel Generator System and the Component Cooling Water Heat Excharger. Since the analysis was done by PGandE, no interface between equipment vendor or suppliers was required.

The Diesel Generator System consists of six major components:

1. Diesel Generators
2. Starting Air Receivers
3. Fuel Oil Filter
4. Fuel Oil Priming Tank
5. Fuel Oil Strainer
6. Fuel Oil Transfer Pump

The Mechanical Engineering Central File Index (Log 5) was reviewed to check for correct and current seismic inputs in the qualifying documents for the above mentioned components. The specific details of each component is discussed at length in Log 3.1.5.

Results of this review show that the Diesel Generator System was conservatively qualified to correct Hosgri seismic input.

The Component Cooling Water Heat Exchanger was qualified by analysis by PGandE. This analysis is located in PGandE mechanical file 140.062G. The analysis was reviewed for correct seismic input. Results of the review show that the analysis used current Hosgri spectra. The analysis is included in Log 3.1.5.

3.3.3.4 Qualification of Building and Components

The Turbine Building design qualification responsibilities were divided between URS/Blume and PGandE.

The qualification of major seismic resistant components of the building for the Hosgri evaluation was performed by URS/Blume and specific drawings which reflect the modifications are included in the report entitled "DCNPP, Unit 1 - Turbine Building Evaluation and Structural Modifications for the

7.5 M Hosgri Earthquake", March 1980 (Log 2.3.2). PGandE implemented modifications to qualify the floor beams, interior columns, interior block and concrete walls and anchorage that were not evaluated by URS/ Blume. Tables 3.3.1 and 3.3.2 contain the list of PGandE drawings for these modifications, obtained from conferring with the responsible engineer.

The PGandE design review is presented in the report "Hosgri Design Verification - Turbine Building", February, 1980 (Log 7).

Since the design review did not verify the interface procedures between URS/Blume, PGandE and the field (Figure 4-10-2, URS/Blume Report on Design Review, Log 7), these will be investigated in the overall reverification program.

TABLE 3.3.1

Drawings prepared by PGandE containing modification information for Structural Frames, Beams and Columns per Hosgri evaluation for the Turbine Building.

465127	465135
465128	465136
465129	465137
465130	465138
465132	465139
465133	465140
465134	465141
	465142
	465143

TABLE 3.3.2

Drawings containing modification information for Equipment Anchorage per Hosgri evaluation for the Turbine Building.

463671	463677
463672	463678
463673	463679
463674	463680
463675	463681
463676	463682
	463683

3.3.4 Auxiliary/Fuel Handling Buildings

The Auxiliary Building is a Class 1 structure and houses service areas for both Units 1 and 2 of the Diablo Plant. In this building are located such facilities as the control room and the fuel-handling area. The building is a reinforced concrete structure except for a steel-framed portion over the fuel-handling area at elevation 140 ft. The design chain and opposite hand symmetry is indirectly addressed in the following sections on the design interface between URS/Blume and PGandE.

3.3.4.1 Design Information from PGandE to URS/Blume

PGandE's Civil/Structure file (Log 4) was searched for the design information transmitted from PGandE to URS/Blume on the Auxiliary/Fuel Handling Buildings during and prior to the Hosgri studies. Specifically, Civil/Structure files No. 9.3, Auxiliary building, and No. 9.31, Seismic Analysis, were searched thoroughly (Log 4). One transmittal issued by PGandE to URS/Blume dated April 16, 1971 was found. In this memorandum, the main steam line anchorage for the G Line in the Auxiliary Building was discussed (Log 1.4).

After discussions with the PGandE responsible engineer in charge of the Auxiliary/Fuel Handling Building design, it was learned that, during the DDE analysis, PGandE developed - with the assistance of URS/Blume - computer programs "Dybox-2" and "Sherwal-4" to compute the mass and dynamic properties of the mathematical model for the Auxiliary/Fuel Handling Building (Log 1.4).

3.3.4.2 Design Information from URS/Blume to PGandE

The flow of information from URS/Blume to PGandE on the Auxiliary Building is documented in Log 2.4.

Preliminary Hosgri spectra were issued by URS/Blume prior to the issuance of the May 9, 1977 (May 11, 1977 transmittal) Hosgri Final Report (Log 2.4.2).

During the qualification of the Auxiliary Building it was decided to make a separate and more detailed finite element model for determining the vertical response of the control room floor due to its relative flexibility. This model is the basis for the control room qualification (Log 2.4.2). Since the final vertical control room spectra are higher than the preliminary spectra, a detailed review of equipment qualification will be necessary in the overall re-verification program to ensure that the equipment was conservatively qualified.

Spectra transmittals after May 11, 1977 provide additional, but not different, information.

3.3.4.3 Design Information from PGandE to Equipment Suppliers and Qualifiers

Seismic qualification of major mechanical equipment is addressed in Section 3.3.4.4.2. Seismic qualification of other equipment and systems is addressed in Section 3.3.7.

3.3.4.4 Qualification of Buildings and Equipment

3.3.4.4.1 Buildings

The statement by the responsible engineer at PGandE in Log 1.4 confirmed that the structural evaluation of the Auxiliary Building was done based on the output from URS/Blume's 7.5 M Hosgri seismic analysis. No effort has been spent, because of time constraints, to spot-check the building qualification details. Because of the reported controversy of weights in the DDE model, a detailed review of the seismic analysis of the Auxiliary Building and its qualification should be performed in the overall re-verification program.

3.3.4.4.2 Equipment

The major equipment of the Auxiliary Building was either qualified by PGandE and Westinghouse or reviewed by Westinghouse. Table 3.3.4.4 summarizes the qualification of mechanical equipment in the Auxiliary Building. The detailed information on this equipment qualification is given in Log 3.1.4.

Component Identification	7.5 M Hosgri Seismic Analysis By	Review Comments
1. Boric Acid Transfer Pump	W	None
2. Centrifugal Charging Pump	W	None
3. Residual Heat Removal Pump	W	None
4. Residual Heat Removal Heat Exchanger	W	None
5. Seal Water Injection Filter	W	None
6. Boric Acid Filter	W	None
7. Boric Acid Tank	W Review	W judged to posses correct Auxiliary Building spectra based on previous seismic qualifications and correspondence history.
8. Component Cooling Water Pump	W Review	
9. Auxiliary Feed Water Pump (Motor Driven)	W Review	
10. Auxiliary Feed Water Pump Motor	PGandE	Calculations on file (See Appendix 3.1.4)
11. Auxiliary Feed Water Pump (Turbine Driven)	PGandE	
12. Auxiliary Feed Water Pump Turbine	PGandE	

TABLE 3.3.4.4 Seismic Qualification Analysis of Mechanical Equipment in Auxiliary Building

3.3.5 Cranes

3.3.5.1 Containment Structure Cranes

There are two cranes in the Containment Structure that required seismic evaluation per 7.5 M Hosgri specification. These are the Polar Crane and the Dome Service Crane. A brief discussion of the two cranes is given in the following sections.

3.3.5.1.1 Containment Polar Crane

The Containment Polar Crane is a gantry crane with trolleys and consists primarily of welded structural steel members and full moment resisting connection. The seismic analysis of the crane as presented in the Hosgri report consists of a 3-D elastic analysis of the crane in a parked position and a 2D inelastic analysis of the crane in an unlocked position. These final results were transmitted to PGandE by URS/Blume through a letter dated September 6, 1971 (Log 2.5). Results of the 2-D inelastic seismic analysis of the crane are presented in the URS/Blume report, "Diablo Canyon Evaluation for the 7.5 M Hosgri EArthquake Progress Report", dated December 1978 (Log 2.5.1). The drawings and other design information utilized for the modeling of the crane are not referenced in the report. Nor are there any transmittals documenting the transfer of these from PGandE to URS/Blume.

These above documents reflect that the design review was completed by URS/Blume and that the results concluded are valid. Two drawings from

PGandE files were checked against both models in the report (Log 2.5.1). This preliminary review shows that the information was transferred correctly from the drawings to the models. In addition, the seismic input to the report was reviewed and is identical to the current Hosgri spectra.

3.3.5.1.2 Dome Service Crane

The dome service crane is a maintenance crane located on top of the polar crane inside containment. Information available to date shows that the crane has been seismically qualified for the Hosgri requirements when it is in the parked position (URS/Blume Report, Log 2.5.1).

Modifications are currently underway to isolate the dome service crane from movements of the polar crane during a seismic event (PGandE Memorandum, Log 7). The crane has been qualified for this modified design for all modes of operation (Log 7). The displacement time histories used in the qualification has been verified as being applicable.

3.3.5.2 Intake Structure Crane

3.3.5.2.1 Design Information from PGandE to URS/Blume

Some design information for the seismic analysis of Intake Structure Crane was transmitted from PGandE to URS/Blume on 1/18/79. More design information for crane, trolley assembly and frames

were respectively transmitted on 12/21/78 and 1/24/79. In February 1979, field measurement of Intake Structure crane was performed (Log 1.5).

3.3.5.2.2 Design Information from URS/Blume to PGandE

URS/Blume requested field measurement and transmitted SK-1-12-9 on 1/23/79. The crane hoist engineering drawings were found to be transmitted on 3/5/79. The final seismic analyses report entitled "DCNPP - Intake Structure Crane Evaluation for the 7.5 M Hosgri Earthquake", November 1979, was transmitted on 11/28/79 and documents the seismic design qualification information for this crane (Log 2.5).

3.3.5.2.3 Qualification of Intake Structure Crane

A quick review of the final report listed in Section 3.3.5.2.2 found many suggested design modifications. They are: the installation of a seismic hold-down and lateral restraint mechanism, and minor structural modifications to transmit horizontal forces from crane legs to truck and then to the rail. These modifications to design drawings were made by URS/Blume and were also reported in the above report. The modifications to construction drawings were jointly made by PGandE and URS/Blume. "As-built" drawings of the crane incorporating the field modifications have been made. Checks are required to compare the "as-built" drawings to the drawings used in analysis. This will be addressed in the long term program.

3.3.5.3 Turbine Building Crane

3.3.5.3.1 Design Information from PGandE to URS/Blume

In the case of the Turbine Building Crane, a formal transmittal of drawings and equipment weights was done on 7/22/75. The transmittal documentation giving the drawing number is listed in Section 1 of Appendix 1.5.

3.3.5.3.2 Design Information from URS/Blume to PGandE

The final report entitled "Diablo Canyon Nuclear Power Plant - Turbine Building Crane Evaluation for the 7.5 M Hosgri Earthquake (Revised)", November 1979, presents the design information required to modify the crane for the Hosgri criteria (Reference 3).

3.3.5.3.3 Qualification of Turbine Building Crane

PGandE qualified the Turbine Building crane with a report on the seismic analysis and structural evaluation by URS/Blume. 3.3.5.3.2 above, URS/Blume modified the crane design to provide tiedown of the crane trolley to the bridge girder and lateral seismic restraint to distribute the lateral seismic loads to both horizontal crane support girders (described in the Hosgri report given in 3.3.5.3.2 above). PGandE and URS/Blume subsequently jointly revised the crane construction drawings. However, checks need to be made to insure that modifications to construction drawings were properly implemented. This will be accomplished in the long term report by comparing the "as-built" drawings to those used in analysis.

3.3.5.4 Fuel Handling Building Crane

3.3.5.4.1 Design Information from PGandE to URS/Blume

Very little documentation was found in PGandE's file on design information transmitted to URS/Blume. Based upon the recollection of the PGandE responsible engineer for the seismic analysis of fuel handling crane (Log 1.5), the latest revisions of crane manufacturer's drawings, original calculations, and material properties of crane were transmitted to URS/Blume. As is the case for some of the other structures, the information was passed on in an informal basis. However, there is no record of URS/Blume's correspondence file on crane which shows that URS/Blume received such information. Some checks need to be made in the overall reverification program to check the applicability of design information transmitted.

3.3.5.4.2 Design Information from URS/Blume to PGandE

The final report entitled "Diablo Canyon Nuclear Power Plant - Fuel Handling Building Crane Evaluation for the 7.5 M Hosgri Earthquake (Revised)" was issued on 9/6/79 (Reference 4). Several minor structural modifications to the existing crane structural system were reported in order to prevent eccentric loading of the crane runway and excessive loading on the trolley axis.

3.3.5.4.3 Qualification of Fuel-Handling Building Crane

The qualification of fuel-handling building crane to satisfy Hosgri criteria was jointly performed

by PGandE and URS/Blume. URS/Blume prepared design modifications per Hosgri report for this crane. PGandE and URS/Blume jointly revised the subject crane construction drawings. In the scope of the overall reverification program some checks will be made to insure that these modifications were done.

3.3.6 Outdoor Water Storage Tanks

3.3.6.1 Design Information from PGandE to URS/Blume

PGandE's Civil/Structure file was searched for the design information transmitted from PGandE to URS/Blume (Log 4). No relevant transmittals were found.

After talking to the lead engineer of PGandE who was responsible for the seismic analysis of outdoor water storage tanks, it was learned that the seismic analyses of these tanks started in March 1977. PGandE and URS/Blume engineers worked closely as a team and the information between PGandE and URS/Blume was exchanged on a person to person basis in meetings, telephone calls, etc. (Log 1.6).

An examination of telecon records kept in URS/Blume's file (Log 1.6) confirms the statement described above by the lead engineer of PGandE. Some design information transmitted between URS/Blume and Harding-Lawson on soil data and stability of tanks was also found in URS/Blume's telecon records. The design information was found to be transmitted informally. Some checks are required in the overall reverification program to insure its accuracy.

3.3.6.2 Design Information from URS/Blume to PGandE

The final seismic analyses were completed in March 1979 and the design information transmitted on March 26, 1979 (Reference 5). Because the tank modifications were being carried out in the field at the same time as the analyses were being performed, nu-

merous revisions were made to PGandE drawings to incorporate URS/Blume's findings. The above report, therefore, reflects the actual configuration and field condition of the tanks (Log 1.6). Although a team effort existed between PGandE and URS/Blume in transmitting the design information, some checks need to be made to determine the accuracy of the information transferred. This task will be accomplished in the overall reverification program.

3.3.6.3 Qualification of Tanks

The tanks were analyzed jointly by URS/Blume and PGandE, using Hosgri criteria as they worked together. URS/Blume's Hosgri report (March 1979) documents the modifications (Reference 5). The outdoor water storage tanks and components were subsequently concluded to meet the Hosgri seismic requirement (PGandE's design verification report for outdoor water storage tanks, dated 9/21/79 (Log 7).

3.3.7 General Equipment and Systems

A significant portion of the scope of this report is to review the interfaces between PGandE and various equipment suppliers and qualifiers. For most equipment, the practical way to check this interface is to examine the end result, the actual seismic qualification and note whether the current applicable Hosgri response spectra curves were used.

The mechanical equipment seismic qualifications are reviewed in the section addressing the individual buildings and will not be included here. This section will deal primarily with the review of seismic qualification of the following equipment and systems.

1. Piping Systems
2. Valves
3. HVAC Components
4. HVAC Ducting
5. Electrical Equipment & Instrumentation
6. Electrical Systems - Raceways and Conduits

3.3.7.1 Piping Systems

This section of the report will address the transmittal of seismic design information from PGandE to consultants engaged in analysis of piping systems and supports.

For the initial Hosgri re-evaluation effort, the piping analysis was assigned to consultants URS/Blume and Earthquake Engineering Systems (EES). Similarly for support evaluation, URS/Blume, EES, and EDS Nuclear, Inc. were used as the primary consultants.

For support evaluation the seismic design input consists of either a table listing seismic load factors as a function of support spacing and building locaiton or the actual support force output from a piping analysis computer model. PGandE uses a formal design guide for the seismic factors which they transmit to the consultants. This will be a significant interface to examine in the overall re-verification program. For instances where piping computer analysis output is used for design, then the valve qualification is totally dependent on the design input to the piping analysis.

The transmittals for piping analyses appear to be in complete form for documents sent to EES. The only problem is that the transmittal cover sheet does not list the contents of the entire attachment. The transmittal might only read problem number and "appropriate spectra attached". To trace the flow of information it will be necessary to find the contents of the transmittals. This task will be

accomplished by further examination of PGandE files or perhaps by examining EES files during the overall reverification program.

For the scope of piping assigned to URS/Blume, very little correspondence was located during the time frame of Unit 1 piping analyses. However, URS/Blume has not yet been contacted to provide any transmittals they may have sent or received. This will accomplished during the long term reverification effort.

3.3.7.2 VALVES

A preliminary review was performed on seismic design information for valves transferred across interfaces between PGandE and testing organizations. This review addresses the safety related valves that required seismic requalification to meet the Hosgri requirements.

The valves reviewed consist of the minimum required active valves for hot shutdown and/or cold shutdown and the valves required in case of a single failure. The containment purge valves are addressed in Section 3.3.1.3.

The valves reviewed are listed in Tables 7-3A,B and 7-7, 7-7A of the Hosgri Seismic Re-evaluation Report (Reference 6). Copies of these tables are contained in (Log 3.2.2).

3.3.7.2.1 Definition of Interfaces

A number of PGandE and contractor interfaces existed. Review of available documentation to date shows that the primary interfaces for valve requalification were:

PGandE → EES → PGandE for piping analysis
PGandE → EDS → PGandE for valve qualification
PGandE → Westinghouse → PGandE for valve qualification

where EES ---- Earthquake Engineering Systems, Inc.
EDS ---- EDS Nuclear Inc.
Westinghouse -- Westinghouse Electric Corp.

EES, using data provided by PGandE, produced computer models of piping systems. Computer analyses were then performed to determine the dynamic characteristics of the piping system under earthquake loading. Results were then transmitted to PGandE.

Earthquake loading was determined from acceleration response spectra provided by PGandE to EES.

PGandE transferred the relevant results of the completed piping analyses, valve accelerations, and pipe loading to EDS and Westinghouse. EDS and Westinghouse then proved that the valve meets certain criteria under the given loading conditions. This was done by either analysis or testing. Results were then transmitted to PGandE.

3.3.7.2.2 Transmittals Between EES and PGandE

No documentation has been found concerning transmittals of information from PGandE to EES at this point in time. A search for this documentation is being continued.

Some records of EES transmittals to PGandE have been found to date. A complete set of EES transmittals to PGandE has not been compiled yet.

Copies of transmittals located thus far are located in Log 3.2.2.

3.3.7.2.3 Transmittals Between EDS and PGandE

A limited amount of documentation of information transferred from PGandE to EDS has been found to date. Complete documentation of requalification information for the valves being reviewed here has not been compiled at this point in time.

Some records of results sent by EDS to PGandE have been located. A complete set of EDS transmittals to PGandE for the valves being reviewed has not been compiled as of this date.

The documentation of information transferred will be further addressed in the long term reverification program. Copies of transmittals identified thus far are located in Log 3.2.2.

3.3.7.2.4 Transmittals Between Westinghouse and PGandE

Some information on PGandE transmittals to Westinghouse has been located in PGandE files. However, insufficient records have been found to fully document information flow from PGandE to Westinghouse.

The only evidence of information returned from Westinghouse to PGandE found to date is a Westinghouse document containing valve seismic qualification forms submitted to the NRC. A copy of this document was sent to PGandE. Also qualification analysis of several valves was included in a Westinghouse report.

Documentation of transmittals between Westinghouse and PGandE located to date are contained in Log 3.2.2.

3.3.7.2.5 Reverification Effort

For valves in flexible piping systems, the acceleration response of the pipe must be known in order to obtain the valve accelerations and to derive the pipe loadings on the valves. This is a result obtained from the piping analyses. Therefore, the validity of a valve qualification depends on information transferred in earlier steps, from PGandE valve qualifiers to the piping analyst and the analysis results from the piping analyst.

With the documentation available to date, no evidence was found to indicate whether the valve accelerations have ever been verified as being correct before being transmitted to the valve qualifiers.

To perform a thorough review of the information transferred across interfaces, the following procedure will be followed on a sampling basis:

1. Locate and examine documentation of correct Hosgri spectra transmitted to piping analysts.

2. Locate and review transmittals of piping analysis results to PGandE, particularly valve accelerations. The accuracy of the piping model is also to be checked.

3. Locate and review transmittals of valve accelerations from PGandE to valve testing organizations.

4. Cross check data returned to PGandE from piping analysts with data transmitted out of PGandE to the valve testing organizations.

3.3.7.3 HVAC Components

PGandE qualified the sixteen groups of cold-shut down required HVAC equipment with the analysis report prepared by EDS Nuclear, Inc. (Table 9-1, Reference 6).

One group of equipment was chosen for review from each of the four buildings: Intake, Turbine, Auxiliary, and Containment. The qualification analyses of the HVAC equipment, listed below, were checked for correct use of current Hosgri spectra.

- Intake - exhaust fans E-101, 102, 103, and 104.
- Turbine - supply fans S-67,68,and 69.
- Auxiliary - supply fans S-31 and 32.
- Containment - forced draft shutter damper

The two equipment groups in the Intake and Turbine Buildings were found to have used correct Hosgri spectra. However, calculations for supply fans S67, 68, and 69 were found to have used incorrect and unconservative seismic inputs. In addition, the forced draft shutter damper qualification showed incorrect seismic definition because gravity had not been added to the vertical acceleration (Log 3.3.1). The forced draft shutter damper has a sufficient factor of safety and is not affected by this error. The safety factors in the calculations for supply fans S67, 68, and 69 are not clearly determined. Therefore, the significance of the input error has yet to be established.

3.3.7.4 HVAC Ducting

The HVAC ducts required for cold shutdown have been qualified by PGandE. Architects, HVAC and civil

engineers of PGandE all collaborated on the duct design. Information flow between these groups is documented in Log 3.3.2.1.

Class I duct at Diablo Canyon Nuclear Power Plant is qualified by analyzing its supports. Some HVAC systems in each of the four buildings (Intake, Turbine, Containment, and Auxiliary) were checked for required cold shutdown.

A random sample of the ducting qualifications in the Auxiliary Building was selected and checked for the applicability of seismic input. Five of the twenty one HVAC support details listed in Log 3.2.2.2 were reviewed. All were found to have used correct Hosgri seismic accelerations.

The only piece of Hosgri required HVAC equipment in the Containment Building is the Forced Draft Shutter Damper (Table 9-1, Reference 6). All ducting in this area is Class II, therefore the seismic inputs were not checked (Log 3.3.2.3).

Hosgri duct support qualifications for the 4KV Switchgear Room HV System have not been located as of October 28, 1981. This is the only HVAC System required for cold shutdown in the Turbine Building. The reverification program will address this area further. Additionally one of three shop modified duct supports in the Turbine Building was checked for seismic input. The calculations were found to have used correct accelerations.

The HVAC System servicing the Auxiliary Salt Water Pump Rooms in the Intake Structure is required for cold shutdown (Table 9-1, Reference 6). Class I ducting to

the exhaust fans is installed under specification 8841 (Log 3.3.2.3). The duct support qualifications for Hosgri seismic inputs were not available on October 28, 1981 PGandE calculations dated November 2, 1981 use correct accelerations (Log 3.3.2.3).

Additionally, the seismic input to the fireproof ducting was reviewed and found to be correctly applied in all cases.

3.3.7.5 Electrical Equipment and Instrumentation

A preliminary review was performed on seismic design information transferred between PGandE and electrical equipment and instrumentation vendors and qualifiers. This review focuses strictly on design information used in requalifying safety related electrical equipment and instrumentation to meet the Hosgri seismic requirements.

The Hosgri Seismic Re-evaluation Report (Reference 6) was used to derive the list of safety related electrical equipment and instrumentation. A copy of Table 10-1 from the Hosgri Report is included in Log 3.4.1. Table 10-1 is a complete list of the safety related electrical equipment and instrumentation.

Although the cable trays are included in Table 10-1, they are reviewed separately and are addressed in Section 3.3.7.6.

3.3.7.5.1 Definition of Interfaces

Although the responsibility for electrical equipment and instrumentation seismic qualification was strictly PGandE scope, the analysis was divided between PGandE and Westinghouse. Westinghouse was responsible for analyzing Westinghouse supplied NSSS equipment. The remaining electrical equipment and instrumentation was qualified by PGandE.

The interface between PGandE and Westinghouse allowed PGandE to send Hosgri spectra information to Westinghouse, and for Westinghouse to send the analysis results back to PGandE.

Of the PGandE qualified equipment, it was qualified by PGandE either by analysis or after testing at Wyle Laboratories.

The Wyle Labs and PGandE interface enabled PGandE and Wyle Labs to exchange information regarding Hosgri spectra, and allowed Wyle Labs to transmit proposed test procedures. Also, Wyle transmitted formal test reports back to PGandE across this interface.

3.3.7.5.2 Transmittals from PGandE to Westinghouse

Documentation of one transmittal of seismic information from PGandE to Westinghouse has been found to date (PGandE Project Letter 1962). However, this transmittal contains only the Newmark earthquake acceleration time histories for the Containment interior at certain elevations.

3.3.7.5.3 Transmittals from Westinghouse to PGandE

Results of the re-evaluation for Hosgri requirements of Westinghouse supplied equipment were submitted to PGandE in the Westinghouse report "Summary Report on Seismic Evaluation for Postulated 7.5 M Hosgri" (Reference 9).

One transmittal from Westinghouse to PGandE has been found to date (Westinghouse letter PGE-4231, dated 9/5/80). It describes the results of an evaluation of Westinghouse supplied equipment to assess the affect of a fifty percent increase in the Hosgri vertical ground spectra (Log 3.4).

3.3.7.5.4 Transmittals from PGandE to Wyle Labs

No documentation has been found to date regarding formal transmittals of spectra from PGandE to Wyle Labs. Seismic information and requirements were informally exchanged between PGandE and Wyle Labs during meetings on July 9 and July 13 of 1977 (PGandE/Wyle meeting agenda July 9, 1977, and reference to meeting in Wyle letter dated July 15, 1977, both in Log 3.4).

3.3.7.5.5 Transmittals from Wyle Labs to PGandE

Two documents that Wyle Labs transmitted to PGandE have been found. These are Wyle letter dated July 15, 1977 and Wyle Feasibility/Trip Report dated August 5, 1977. These do not contain specific technical data, but discuss general approaches proposed for qualification of Class 1E electrical equipment.

Other transmittals from Wyle Labs to PGandE are Wyle test reports and test procedures. Two of these that were given cursory review are Wyle Labs Test Procedure No. 3642 and Test Report No. 58255 (Reference 10).

3.3.7.5.6 Transmittals Regarding Requalification by Analysis

Requalification of electrical equipment and instrumentation (other than Westinghouse NSSS equipment) by analysis was done in-house at PGandE.

3.3.7.5.7 Westinghouse Requalification of Electrical and Instrumentation Equipment

Review of the Westinghouse report, "Summary Report on Seismic Evaluation for Postulated 7.5 M. Hosgri", (Reference 9) showed that Westinghouse electrical equipment and instrumentation was requalified for Hosgri requirements by applying certain criteria to previously performed tests and analyses.

The test spectra used in the previous tests are included in Log 3.4. These are identical to Figures 10-2 to 10-12 in the Hosgri report. The Westinghouse report states that the 5-9-77 spectra were used and that the Blume and Newmark spectra were enveloped.

The report also states that the vertical spectra used were taken as 2/3 of the horizontal spectra. However, in a conversation with the cognizant engineer from Westinghouse, he states that specific vertical Hosgri spectra were used in the requalification of each item of equipment. The engineer also stated that the vertical spectra for control room equipment were selected with consideration for the node point closest to the equipment location.

Requalification was performed by Westinghouse by comparing the applicable Hosgri spectra to test spectra used in the initial pre-Hosgri qualification

Westinghouse also assessed the effect of a 50% increase in the vertical Hosgri spectra on Westinghouse supplied equipment. Results of this evaluation were transmitted to PGandE in Westinghouse Project Letter PGE-4231, Revision 1, dated 9/5/80 (Log 3.4).

3.3.7.5.8 Wyle Requalification Tests

Though no documented transmittals from PGandE to Wyle have been found to date, there is evidence that Wyle test procedures were reviewed and approved by PGandE personnel:

1. A PGandE memorandum, dated 11-9-77, contains comments on proposed test spectra contained in Wyle Report No. 26286.

2. Wyle Test Procedure No. 3642, dated 11-30-77 is signed and approved by appropriate PGandE personnel.

Documentation on these two items is contained in Log 3.4.

PGandE internal memorandum indicates that General Electric was involved in Wyle Labs requalification tests of the 4.16kV Vital Switchgear and provided input to the test procedures. Test results are included in Wyle Labs Test Report No. 58255-1, dated 8/22/78.

3.3.7.5.9 Requalification by Analysis

For equipment requalified by analysis, as indicated by note 5 in Table 10-1 of the Hosgri report, no information has been found to date as to who had performed these analyses. Investigation in this area will be continued.

3.3.7.5.10 Preliminary Review of Electrical Equipment

A preliminary review of requalification of electrical equipment and instrumentation was conducted by checking a 50% sample of zero period accelerations (ZPA's) from the Hosgri Evaluation listed in Table 10-1 of the Hosgri report.

The listed Hosgri ZPA's were cross checked against the ZPA's of the applicable up-to-date Hosgri spectra. The Hosgri ZPA's in Table 10-1 were found to be correct.

In each case, the ZPA levels used to qualify each item of equipment, as listed in Table 10-1, were greater than the required Hosgri ZPA's.

3.3.7.5.11 Reverification Approach

Should further investigation fail to uncover records that satisfactorily document the transfer of seismic requalification information between PGandE and their consultants, the following procedure will be undertaken:

1. Actual test spectra used in requalification tests will be examined. They will be checked to see if they envelope the applicable Hosgri spectra.

2. Requalification analyses will be examined to check if the applicable seismic information was applied. In addition, the analysis criteria used for qualification, if applicable, will be examined.

3.3.7.6 Electrical Raceways

The supports for the Electrical Raceways are found throughout the main buildings. Originally it was understood that about 600 individual unistrut support designs were developed. In practice however, only about 400 were actually used and re-evaluated for the Hosgri earthquake. The PGandE civil engineer responsible for electrical Raceways provided the qualification documentation. Each support detail is qualified to the Hosgri by a quasi-static seismic analysis. This analysis is keyed to the PGandE design standard that requires supports to be placed at 8' intervals or less.

With such a large volume of material, a random sampling approach was employed. The Hosgri seismic accelerations were checked for ten support details (Log 3.4.2.3). In addition, the program employed in September 1981 by PGandE to requalify the raceways in the Annulus section of Containment was checked. The Annulus region was closely examined for the following three reasons:

No transmittals of Annulus drawings from PGandE to URS/Blume were located and URS/Blume does not, at present, have the drawings. Preliminary spectra differing from the 5/9/77 spectra were issued for Containment. New spectra (7/21/77) superseding the 5/9/77 Hosgri Report were issued (Log 2.1.2).

The quasi-static qualification was based upon application of the 4% floor response spectra. The plan was to qualify all conduit supports to these floor spectra, assuming that each conduit was

filled with cable amounting to no more than 40% of the cross sectional area. On the average however, they were filled to less than 40%.

The qualification plan provided for using 7% damping if satisfactory results were not obtained in the original analysis. This is based upon use of R.G. 1.61 damping for bolted structures. Of the ten calculations that were reviewed one was explicitly based upon accelerations associated with 7% damping.

Six of the sample of 10 used acceleration values that did not correspond with the Hosgri floor spectra for the location of interest. Of the 6 it appeared that possibly 2 used reduced spectra consistent with 7% damping, but without explicitly stating that this was done.

Four of the sample of ten used acceleration values that did not correspond with the Hosgri floor spectra. These cases appear to be an incorrect application of design spectra. Further checking showed that 2 of these 4 did use acceleration values corresponding to 7% damping curves of a preliminary issue of the design spectra.

No design spectra corresponding to 7% damping were routinely issued. Acceleration values for this damping were obtained by taking 70% of the 4% damping values.

As a result of the use of inapplicable spectra in the first sample, an additional random sample of ten support details was checked. It was found that

five of the sample of ten used acceleration values that did not correspond with the Hosgri floor spectra.

In summary, nine of the twenty raceway support seismic calculations were found to have been done with inapplicable spectra. Further checking indicated that two of the nine may have exceeded allowable stresses if the correct spectral values were used. Since the quasi-static calculation method employed is quite conservative, the overstress may be reduced to within allowable stress if a refined method is used for design.

4.0 SUMMARY AND DISCUSSION

This report has been prepared in response to the NRC request for a preliminary report on the PGandE Hosgri Reverification Program. As requested, it covers a review of the design chain, opposite hand symmetry and the applicability of seismic design and qualification information for the Hosgri earthquake that may be considered to be associated with design interface between PGandE and URS/Blume. As illustrated in Figure 3.1, the design applicability was reviewed for the entire seismic chain beginning with basic plant design information developed at PGandE, through the URS/Blume interface, then back to PGandE and on to the equipment vendors and consultants.

In this preliminary report, the goal was to review the design chain, opposite hand symmetry and applicability of all major design issues and identify all detailed equipment qualifications for later review. Because of a large number of these, a certain level of sample checking was performed. To accomplish the basic objective, the review was performed on a building by building basis, except in the case of general equipment, such as piping systems, HVAC systems, etc., which were grouped together for all buildings. The findings, by building and general equipment, are reported below.

Containment

The Hosgri evaluation was performed using the original models for the DDE evaluation based upon 1970 drawings. Current drawings were reviewed for revisions and changes. No changes were sufficient to require re-modeling. There were few formal transmittals from PGandE to URS/Blume in the early time period, because engineers from the two organizations were working together as though

in one organization.

The annulus area lacked formal transmittals and was found to have been modeled using the Unit 2 configuration, as was known.

With the exception of the annulus, the Containment Building models were based upon applicable drawings.

URS/Blume performed the seismic analysis of the Containment Building and supplied several well documented reports to PGandE.

PGandE received the well documented seismic results from URS/Blume. Building response spectra were supplied to equipment suppliers to permit equipment qualification. The applicability of the design information for the following major equipment was verified:

Reactor Coolant System (RV, SG, PCP, Piping)
Hydrogen Recombiner
Containment Purge Valves
Containment Fan Coolers

For the case of the Regenerative Heat Exchanger, Westinghouse used an incorrect vertical response spectra in the seismic analysis. Use of the correct vertical spectra would increase the loads and could reduce the safety factor to unacceptable levels.

Other equipment in the Containment Building is discussed in the equipment section.

Intake Structure

The seismic analysis of the Intake Structure was based upon information contained in a transmittal from PGandE in 1976. This transmittal was examined. URS/Blume issued a report on the seismic analysis of the Intake Structure in April 1977. After modifications, it was finalized in 1979. The drawings used to prepare the model were outdated, but building revisions were minor and did not affect the analysis.

Turbine Building

There was no design interface between PGandE and URS/Blume in the initial aspect of the design and qualification because URS/Blume had complete design responsibility for the building.

The building had to be modified to qualify it for the Hosgri earthquake. All relevant drawing numbers have been obtained, and a complete design verification effort completed by PGandE was documented. The in-depth verification was left to the final reverification program since this building is less important than certain others.

The diesel generator, including the fuel system and starting air receivers, was reviewed. The correct

seismic input information was used for this safety related equipment.

Auxiliary/Fuel Handling Building

The Hosgri requalification of the Auxiliary Building was performed with essentially the same models used in the earlier DDE analysis. These models were developed jointly by PGandE and URS/Blume using specialized computer programs for computing building properties. Reports of reviews of building properties and configurations were noted prior to initiation of the Hosgri analysis. Some building plans used in developing the dynamic model as reported in the URS/Blume report were checked with the as-built building drawings. Although minor differences exist, the dynamic model used reasonably represents the structural configurations. Records of discussions on model properties however, suggests that limited checks on mass and stiffness should be made in the verification study.

Cranes

For the most of the cranes, the design information was provided to URS/Blume on an informal basis. For each of the major cranes in the plant, URS/Blume issued a complete design report. In addition, a design review was completed by URS/Blume for the Containment Dome Service Crane. These are positive findings, however, in some cases the qualification report does not have a complete record of drawings upon which models were based.

Also during the Hosgri requalification, some of the cranes were modified with the addition of holddowns, lateral restraints, etc. Additional checks to ensure analysis reflected the as-modified drawings would be beneficial.

Outdoor Water Storage Tanks

The information transmittal from PGandE to URS/Blume for qualification of the outdoor tanks was done on an informal basis since the two organizations were working together as a team. Substantial modifications were made to these tanks in the course of the Hosgri requalifications. Indirect interfaces existed in the analysis of these tanks via Harding-Lawson, soil consultants, since one of the modifications was to dig out under the tank foundation and strengthen this structure. Communications were informal in many cases. However, this area will be reviewed in much more detail in the final program because there was an indirect interface and because of informal communications.

General Equipment and Systems

1. Piping and Valves

A large number of transmittals were documented in which information was exchanged between PGandE and consultants. However, the contents of the transmittals have not yet been located, and therefor the correctness of analysis results output could not be verified at this time.

2. HVAC Components and Ducting

HVAC components and ducting qualification were reviewed for correct seismic inputs. In two cases, HVAC components were qualified with incorrect seismic inputs. One of the two cases did not consider gravity in the computation of

vertical response. But because of a large safety factor, this qualification is satisfactory. For the second case, additional review shall be necessary.

For the HVAC ductings reviewed, qualifications for two cases were not found prior to October 28, 1981. However, one of these two HVAC ductings has since been qualified.

3. Electric Equipment, Instrumentation and Conduits

A cursory review of qualification procedures for electrical equipment and instrumentation show no errors for the seismic inputs.

In the case of electrical conduits, nine of the sample of twenty support designs checked did not use seismic acceleration values consistent with the Hosgri spectra. PGandE is currently reviewing qualifications of all conduit support details.

The annulus zone of the Containment Building was not studied as part of this effort since this zone is undergoing re-analysis at the present time. The annulus zone vertical response model is mainly composed of structural steel and equipment. It is estimated to have the highest ratio of equipment to structure weight of any part of the plant. The annulus horizontal response is coupled with and dominated by the response of the Containment interior structure. Elsewhere in the main safety related buildings, Containment, Auxiliary and Intake, the floor response spectra will be relatively insensitive to equipment weight

since the models are dominated by the mass and stiffness of structural concrete.

The applicable building drawings were found to be used in developing the dynamic models. Although minor differences exist between building drawings used in the dynamic analyses and the as-built drawings, these differences will not appreciably change the building response as it is insensitive to minor changes in building dynamic model parameters.

5.0 CONCLUSIONS

In the course of this preliminary work a great deal of material has been reviewed. The review was conducted on the engineering material itself. The present findings and conclusions are independent of the normal convolutions of the design process, and whether work was done formally or informally, with the exception, of course, that informal transmittals, etc. require additional verification of the end product.

The design information reviewed that was transmitted to and used by URS/Blume was found applicable. The design information transmitted from URS/Blume to PGandE was also found applicable.

In general, correct spectra were transmitted from PGandE for equipment qualification. At this interface, cases of inapplicable seismic response spectra for equipment qualification were identified. These appear to be isolated cases.

The overall conclusion drawn from the work to date is that the seismic qualification of Diablo Canyon for the postulated Hosgri Earthquake is satisfactory in its main features. The building responses are based upon use of applicable design information and seismic responses of the buildings are not overly sensitive to minor changes in parameters. Therefore, the floor response spectra are not expected to change in a significant way in the future if additional design discrepancies are found.

The design interface between PGandE and URS/Blume for the Hosgri requalification of Diablo Canyon Nuclear Power No. 1 has been sufficiently reviewed. This review has met the

NRC request to ensure that there are no systematic or major design discrepancies. A more complete review* will be performed from the present time to power ascension. The completion of this program will constitute a detailed reverification of the seismic adequacy of the Diablo Canyon Nuclear Power Plant No. 1.

*Seismic Reverification Program, October 30, 1981, Robert L. Cloud Associates, Inc., Berkeley, CA

DRAFT

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