UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING APPEAL BOARD

In the Matter of: PACIFIC GAS AND ELECTRIC COMPANY (Diablo Canyon Nuclear Power Plant, Units 1 and 2)	Docket Nos. 50-275 O.L. 50-323 O.L.

TESTIMONY ON BEHALF OF THE INDEPENDENT DESIGN VERIFICATION PROGRAM

OF

Dr. Robert L. Cloud
Professor J. M. Biggs
Professor M. J. Holley, Jr.
Mr. Ronald Wray

REGARDING

CONTENTIONS 3 and 4.m.-n.

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TESTIMONY REGARDING CONTENTIONS 3, and 4.m.-n.

INTRODUCTORY TESTIMONY

Q.1: Please state your name, current position, business address and qualifications.

A.1: (RLC) This information is provided in A.1 of the Testimony Regarding Contentions 1, 2, and 5-8.

(JMB) I am Professor John M. Biggs, Principal in the firm of Hansen, Holley & Biggs, Inc. and Professor Emeritus in the Department of Civil Engineering, Massachusetts Institute of Technology. My business address is Box 88, MIT Branch Post Office, Cambridge, Massachusetts, 02139. My educational background and professional experience are summarized in Attachment 1 to this testimony.

(MJH) I am Professor Myle J. Holley, Jr., Principal in the firm of Hansen, Holley & Biggs, Inc. and Professor Emeritus in the Department of Civil Engineering, Massachusetts Institute of Technology. My business address is Box 88, MIT Branch Post Office, Cambridge, Massachusetts, 02139. My educational background and professional experience are summarized in Attachment 2 to this testimony.

(RW) I am Ronald Wray, Manager of Engineering Analysis for Teledyne Engineering Services, 130 Second Avenue, Waltham,

Massachusetts, 02254. My educational background and professional experience are summarized in Attachment 3 to this testimony.

Q.2: What role did you play in the IDVP's effort?

A.2: (RLC) My role is described in A.2 of the Testimony Regarding Contentions 1, 2, and 5-8.

(JMB, MJH) The firm of Hansen, Holley & Biggs, Inc. was retained by the IDVP to provide additional expertise in the area of civil and structural engineering, and we were the two members of the firm who performed work for the IDVP. We assisted the other IDVP participants in the review of structures and in the preparation of the building ITRs. We also participated in numerous open meetings with the DCP, NRC and designated other parties, relating to the civil/structural aspects of the IDVP's work.

(RW) I was an Assistant Project Manager for the Teledyne Engineering Services effort as overall manager of the IDVP. In this role, I was responsible for managing the efforts of RLCA in verifying the seismic, structural, and mechanical aspects of the design process. I also reviewed and approved all of the ITRs issued in these areas.

Q.3: Does every answer in this testimony constitute the testimony of all four members of the panel?

A.3:(All) Yes, with the exception of contention 4.m., which represents the testimony of only Dr. Cloud and Mr. Wray. For all other parts of the testimony each member of the panel has some familiarity with the subject areas of the contentions addressed and has reviewed and approved the conclusions expressed herein. However, some of us were more closely involved in the IDVP's work

in some of these subject areas than in others, and our roles in the IDVP effort were different. Therefore, we have attempted in each subpart of the contentions addressed by this panel, to designate the panel members who are more familiar with that subject area. This is indicated both by naming those panel members who were most closely involved in the areas addressed and by listing the panel members approximately in order of our relative knowledge and involvement.

Q.4: What is the purpose of this testimony?

A.4: Contention 3 lists a number of "instances" in which the ITP is alleged to have used "improper engineering standards to determine whether design activities met license criteria." The IDVP is said to have used or approved the use of the improper standards or not to have verified them at all. This testimony addresses each instance cited. Contentions 3(a), (b), (h), (l), and (m) were eliminated by Appeal Board Order of October 7, 1983.

Contention 4 alleges that the IDVP permitted deviations from licensing criteria in certain specific instances. This testimony also addresses subparts 4.m. and 4.n.

CONTENTION 3.c. (RLC, JMB, RW)

"The ITP failed to specify all damping values used in various seismic modes in the containment and auxiliary buildings in that, for containment for the DE and the DDE, different damping values are used in different components of the system, but the resulting values of damping for each mode in the modal analysis are not specified. For the auxiliary building, values of damping for each mode in the modal analysis are not specified, and the ITP has not specified what damping values, if any, were used for the soil springs."

Q.1: Did the IDVP verify the damping values used in the ITP's analysis of the containment and auxiliary buildings?

A.1: The IDVP verified that, as specified in the DCP Phase I Final Report, Section 2.1.2, the appropriate value of damping was used for all modes for the dynamic analysis of the auxiliary building for the Hosgri and DE-DDE analysis. The licensing basis values of damping of 7% (Hosgri) and 5% (DE-DDE) were used for each mode, as required in Section 4.1 of the Hosgri Report and Section 3.7.1 of the FSAR. The IDVP's verification is reported in Sections 4.2.7 and 4.2.9 of ITR-55. The design review packages (DRPs) in which these design reviews are found are references 16 and 23 in this ITR.

The dynamic analysis calculation package for the containment building was not part of the IDVP sample, and therefore the damping values used in this analysis were not reviewed.

Q.2: Did the IDVP verify damping in any part of the containment building analysis?

A.2: Yes. The polar crane within the containment was part of the IDVP sample and did have a dynamic analysis. The IDVP verified that, as specified in the PGandE Phase I Final Report, Section 2.1.1, the licensing basis damping value of 7% for the

Hosgri earthquake was met for this dynamic analysis. In this case, a conservative application of mass-stiffness proportional damping was used by the ITP which resulted in less than 7% effective damping for most of the modes of vibration. (See Section 4.2.14 of ITR-54 and Ref. 13 therein.)

The IDVP also verified that the 7% damping value was used in the analysis of the containment annulus for the Hosgri earthquake. This value is the licensing criterion. (See Sections 2.6.6 and 4.1.1 of ITR-51.)

Q.3: Did the IDVP verify the damping value used for the soil spring in the auxiliary building model?

A.3: Yes. The IDVP verified that, conservatively, no contribution of soil damping per se was included. (See Sections 4.2.7 and 4.2.9 of ITR-54 and References 16 and 23 therein.)

Q.4: Is the IDVP aware of any improper use of damping values by the ITP for the analysis of the auxiliary building, containment building, and the soil springs for the auxiliary building model?

A.4: No. For the auxiliary building, the damping values used in the analysis for the Hosgri and DE-DDE were those specified as the licensing criteria. For the soil springs used in the auxiliary building model, no contribution of soil damping per se was included, which gives a conservative result. For the containment building, the IDVP sample did not include the dynamic analysis calculation package containing the analysis of the building for the DE and DDE. However, for the portions of the containment reviewed by the IDVP, the proper damping values were employed.

CONTENTION 3.d. (RLC, RW)

"The ITP failed to verify that PGandE's use of the double algebraic sum method of calculation (rather than the sum of the squares method) was an acceptable substitution in the Phase I Final Report's calculation of member forces for the Hosgri event, where the double algebraic sum method is used solely for closely spaced modes, and the sum of the squares method is used elsewhere."

Q.1: Did the IDVP address the methods used for combining modal contributions in the evaluation of members in the DCNPP-1?

A.1: Yes, the IDVP did address this topic.

Q.2: Do licensing criteria require the use of only the Square Root Sum of the Squares (SRSS) method?

A.2: Yes. This requirement is stated in the Hosgri Report, Section 2.2.2, as it relates to the DE-DDE, and in Section 4.1, as it relates to Hosgri.

Q.3: Did the ITP employ the double algebraic sum (DAS) method when evaluating the DCNPP-1 for Hosgri loads?

A.3: The IDVP verified in all the calculations of member loads for the DCNPP-1 buildings within the IDVP sample that only the SRSS method was relied upon by the ITP for member evaluation to meet licensing criteria, as reported in the building ITRs. The IDVP observed that forces and moments were determined in some cases for member loads on a DAS basis in turbine building members. However, the IDVP verified that the SRSS method was employed in the final qualification of record. (ITR-56, Rev. 1, Section 4.2.8.)

Q.4: Is the IDVP aware of any improper methods used to compute modal combinations in the DCNPP-1?

A.4: No. Appropriately, only the SRSS method was employed

in the qualification of building members to meet licensing criteria.

CONTENTION 3.e. (RLC, JMB, RW)

"The ITP's use of time-history modeling techniques for some accelerations, displacements and shell forces in the containment structure and Blume response spectra for other accelerations, displacements and shell forces in the same structure was improper."

Q.1: Did the IDVP address the ITP's use of time-history modeling for some accelerations, displacements, and shell forces in the containment structure and the ITP's use of the Blume response spectra for other accelerations, displacements, and shell forces?

A.1: Yes. This is reported in Section 4.2.3 of ITR-54 and Ref. 9 therein.

Q.2: What types of analyses did the ITP perform?

A.2: A time-history analysis was performed by the ITP in both the vertical and horizontal directions. This analysis was used to compute in-structure response spectra for use in evaluation of equipment, piping, etc.

In addition, the structural member loads were determined from the horizontal time-history analysis. The loads constitute the horizontal contribution to the seismic loading. The vertical contribution to the structural loading was computed separately from a response spectra analysis, using the controlling Newmark ground spectra for the Hosgri earthquake.

Q.3: Was this method of combining forces used in the original Hosgri evaluation for the DCNPP-1?

A.3: Yes. This methodology was approved by the NRC Staff in SER Supplement 7, Section 3.8.5.4.

Q.4: Is this a proper method for obtaining the horizontal

and vertical components of the seismic load on the structure and, if so, why?

A.4: Yes. It is entirely proper to combine the results obtained from use of a time-history analysis in the horizontal direction and the results obtained from use of a response spectra analysis in the vertical directions.

A time-history analysis is required to obtain accurate in-structure response spectra, therefore it must be performed. However, for the member evaluation, it makes little difference technically whether seismic structural loads are computed on a time-history basis or a response spectra basis. For this purpose, the two methods are equally acceptable alternatives for accomplishing the same results. The licensing criteria do not specify the exclusive use of one method over the other. Peak values for the different directions are combined by the square root of the sum of the squares (SRSS) and either method may be used to compute the individual peak values.

Q.5: Is the IDVP aware of any improper use of time-history modeling for some purposes and Blume response spectra for others?

A.5: No. The IDVP has concluded that this use of time-history modeling and Blume response spectra is entirely appropriate and consistent with licensing criteria.

CONTENTION 3.f. (RLC, RW, JMB, MJH)

(f) The ITP's modeling of the soil properties for the containment and auxiliary buildings was improper in that:

(i) in the soil structure interaction analysis of containment for the DE and the DDE, use of boundary motion inputs to the model were improperly used;

(ii) the soil structure interaction analysis for containment for the DE and the DDE uses a 7 percent damping value for rock, which is unconservative, especially for the DE;

(iii) the dynamic analyses of the containment for all earthquakes omit any analysis of uplifting of the foundation mat;

(iv) the modeling of the soil springs for the auxiliary building does not specify soil properties;

(v) in the modeling of the soil springs for the auxiliary building, the motion inputs to the lower ends of the springs does not account for all soil structure phenomena that could be expected.

Q.1: Did the IDVP address the issues in Contention 3 (f) (i) and (ii)?

A.1: No. The IDVP did not address those issues.

Q.2: Why not?

A.2: Those subparts of the contention address specific details in the soil-structure interaction analysis for the containment, and that analysis was not part of the IDVP sample for the soils review.

Q.3: Did the IDVP sample any of the soil work, and if so what did it sample?

A.3: Yes. The IDVP took an extensive sample of the soils work, including the soil-structure interaction analysis of the diesel fuel tank, the auxiliary saltwater piping, the sliding and overturning analysis of the intake structure, a review of the soils tests and others. These samples are described in ITR-68.

Q.4: Did the IDVP address the issue alleged in Contention 3(f) (iii) concerning base-mat uplift for the containment building?

A.4: No. This particular calculation was not part of the IVDP sample.

Q.5: Does the IDVP know whether uplift of the containment building was reviewed by the CAP?

A.5: Yes. An important element of the IDVP verification of the CAP was to obtain an index of all calculations for each building as a check on the completeness of the CAP's review. This index indicated that overturning calculations were performed (see ITR-54, App. A). In addition, at a public review meeting on May 4, 1983, the DCP described additional work performed on the study of tilting.

Q.6: Turning to Contention 3(f) (iv), did the IDVP address the modeling of the soil springs for the auxiliary building and the soil properties upon which it is based?

A.6: Yes. The reviews of the soil springs in the auxiliary building dynamic models are reported in ITRs-6 and -55.

Q.7: Are the soil properties specified in these models?

A.7: The calculations that derive soil spring characteristics have a clear description of the properties used. The properties of the soil are also presented in detail in the FSAR, App. 2.5a. The IDVP verified that the soil properties chosen by the ITP were sufficient to model the soil springs in an appropriate manner.

Q.8: Turning to Contention 3(f)(v), did the IDVP address the issue of the motion inputs to the lower ends of the soil springs for the auxiliary building?

A.8: Yes.

Q.9: What was the motion input to the soil springs used in the ITP analysis?

A.9: The time history of the ground motion for both Hosgri and DE-DDE has an associated response spectra that envelopes the design basis ground spectra for these licensing earthquakes (4.3.1 of Hosgri Report; FSAR, Figures 3.7-1 through 3.7-4). For both the DE-DDE and Hosgri earthquakes, the ITP assumed a fixed base at elevation 85' and used a soil spring representation at elevation 100'. The input motion of the appropriate earthquake was used as input to both the soil spring and the fixed base portion of the auxiliary building for both the horizontal motion and the vertical motion.

Q.10: Is this an appropriate model and method of performing seismic dynamic analysis of the auxiliary building and its soil springs to ensure the design basis earthquake motion is correctly considered?

A.10: Yes. The model and method used constitute a reasonable approximation of the structure and its foundation. This conclusion is supported by parametric studies performed by both the ITP and the IDVP. These studies showed that large differences in the soil spring properties produce differences in the auxiliary building motion that are negligible.

Q.11: In the particular analysis done for the DCNPP-1 auxiliary building, were all soil-structure interaction phenomena considered?

A.11: No. However, any such omissions would not have a significant effect for the reasons stated in A.10.

Q.12: Is the IDVP aware of any improper modeling of soil properties for the auxiliary and containment buildings as alleged in this contention?

A.12: No. To the extent these were within the scope of the IDVP's review, the IDVP is aware of no such improper modeling.

CONTENTION 3.g. (RLC, MJH, RW, JMB)

"The ITP's modeling of the crane in the turbine building was improper in that it models the crane only for a single (parked) position and load (unloaded)."

Q.1: Did the IDVP review the ITP's modeling of the turbine building and the effect of the crane thereon?

A.1: Yes.

Q.2: In the review of the turbine building, did the IDVP consider it proper for the ITP to account for only one position and status of the turbine building crane (parked and unloaded)?

A.2: Yes. PGandE has committed to maintain the turbine building crane in the parked and unloaded condition until the turbine building has been qualified for operating conditions. (DCP Phase I Final Report, Section 2.1.4).

Q.3: Did the IDVP also review the ITP's modeling of the turbine building crane itself?

A.3: No.

Q.4: Why not?

A.4: The IDVP chose one major crane at DCNPP-1 for in-depth verification and, for this sample, the IDVP sought to choose the most important crane at the site. This was judged to be the polar crane in the containment, because of its function, location, and complexity of design. The IDVP's verification of the CAP's analysis of the containment polar crane did not identify any reason to expand the sample to any of the three additional large cranes located at the DCNPP-1.

CONTENTION 3.i. (RLC, RW, MJH)

"The ITP's modeling of hydrodynamic forces for the intake structure were improper in that sloshing effects for the inside water and hydrodynamic pressures on the outside of the structure were not considered."

Q.1: Did the IDVP consider the modeling of hydrodynamic forces for the intake structure?

A.1: Yes.

Q.2: How did the ITP consider hydrodynamic effects?

A.2: The ITP considered the most significant effect of hydrodynamic loading. In the IDVP's view, the major forces and the only significant hydrodynamic loads are the inertial load of the water mass that acts directly against the inlet piers or flow straighteners in a north-south earthquake. The IDVP noted that this force was considered in a conservative manner in the IDVP's design review of the ITP's analysis of the piers. (ITR-58, Section 4.2.9)

Q.3: Why is this the most significant force?

A.3: This is the most significant force because the water mass in question is bounded by the flow straightener walls on the north and south. In the east-west direction the water is unbounded in a westerly direction, and the eastern boundary of the water consists of massive convergent concrete sections. The flow straightener walls must resist the large hydrodynamic inertia load, primarily in north-south bending.

Q.4: Are there other significant hydrodynamic effects, such as sloshing?

A.4: Sloshing effects will be present to a limited degree. However, the sloshing loads in this configuration and type of

structure are not significant compared to the loads discussed in A.3.

Q.5: Does the IDVP conclude that the ITP adequately considered hydrodynamic forces for the intake structure?

A.5: Yes. The ITP considered the only significant hydrodynamic loads acting on the intake structure in a conservative manner.

CONTENTION 3.j. (JMB, RLC, RW, MJH)

"The ITP's modeling of the intake structure by using different models for horizontal and vertical seismic loadings and combining vertical and horizontal responses was improper in that the modeling of the crane combines linear and nonlinear analyses for the different loads without justification."

Q.1: Did the IDVP address the modeling of the DCNPP-1 intake structure?

A.1: Yes.

Q.2: Did the ITP use different models for the east-west and north-south directions?

A.2: No. The east-west analysis, the north-south analysis, and the vertical analysis were performed on the same model, with appropriate changes in boundary conditions (see ITR-58, Section 4.2.3). The analysis of this structure in all three directions was a linear analysis. There is therefore no basis for any allegation that different models were used to analyze horizontal and vertical loadings.

Q.3: Did the IDVP verify in detail the modeling of the intake structure crane?

A.3: No. This crane was not part of the IDVP sample. However, the IDVP does have some knowledge of how the crane was modeled. The crane was modeled and analyzed separately from the building, except that the mass of the crane was considered in the dynamic analysis of the building. After the crane was analyzed, the reactions on the building were considered in the member evaluation (DCP Phase I Final Report, Section 2.1.4).

Q.4: Was the analysis of the crane non-linear?

A.4: Yes, in the sense that the cable that carries the

crane load can only carry tension and not compression. This effect is only important in the vertical direction.

Q.5: Is it appropriate to combine the results of a linear horizontal analysis with the type of non-linear vertical analysis described in A.4?

A.5: Yes.

Q.6: Is the IDVP aware of any improper combining of linear and non-linear analyses as alleged in tne contention?

A.6: No. The IDVP has not attempted to verify the modeling of the intake structure crane. However, based on its knowledge of the intake structure itself, including some knowledge of the modeling of the crane, the IDVP does not believe that there has been any improper combining of linear and non- linear earthquake loadings in the ITP's analysis.

CONTENTION 3.k. (RLC, MJH, JMB, RW)

"The ITP's modeling of the intake structure by using ductility factors for steel and concrete was improper in that no explanation or justification for ductility are provided, and in that a post yield analysis was apparently done to determine pier ductility characteristics, also without justification or listing of results."

Q.1: Did the IDVP address the use of ductility factors for reinforced steel and concrete in the intake structure?

A.1: Yes. The IDVP verified that the ductility limits employed by the ITP were consistent with the licensing basis ductility factors referenced in the Hosgri report. (Hosgri Report, Section 4.1.3)

Q.2: Was the IDVP able to verify that ductility demands were properly estimated?

A.2: Yes. The IDVP reviewed the calculations for the ductility estimates of the intake structure piers. A post-yield analysis was required to prove that the ductility predicted if the Hosgri earthquake struck in a north-south direction would be within the limits of the licensing basis. The analysis showed that it would be.

Q.3: Is the IDVP aware of any use of incorrect ductility limits or any incorrect calculation of ductility demands in the ITP's analysis of the intake structure?

A.3: No. The IDVP has verified that the ductility limits employed in the analysis of the intake structure were consistent with the applicable licensing criteria. The IDVP also verified that the method used to determine ductility demands was proper.

CONTENTION 3.n. (RLC, MJH)

"The ITP's stress value for concrete in shear walls used in modeling the auxiliary building was improper in that the stress value (allowable) used for shear in the concrete walls is large, is less conservative than what is provided in ACI 318-77, and may cause wide cracks."

Q.1: Did the IDVP address the criteria for evaluation of shear walls in the auxiliary building?

A.1: Yes.

Q.2: What allowable stress criteria were used by the ITP in the shear wall calculations for the auxiliary building?

A.2: The licensing criteria required the use of ACI-318-63. (FSAR, Section 3.8.1; Hosgri Report, Section 4.5.3) The DCP used test-based allowable stress criteria as permitted by ACI-318-63, Section 104. Contrary to Governor Deukmejian's assertion in his Answers to PGandE's Second Set of Interrogatories (No. 88), the DCP did not use the value "10(sqrt(f'c))" in its wall evaluations.

Q.3: Does the application of these criteria to the DCNPP-1 raise a concern about "wide cracks" in the auxiliary building concrete?

A.3: In the event of an earthquake of Hosgri magnitude at DCNPP-1, it is the opinion of the IDVP that any concrete cracking that occurs will not compromise the structural integrity of the buildings.

Q.4: Is the IDVP aware of any improper use of stress values used for the auxiliary building concrete?

A.4: No. The IDVP has concluded that the ITP employed the appropriate licensing criteria.

CONTENTION 3.o. (RLC, JMB, RW)

"The ITP has not demonstrated, and the IDVP has not verified, that the DCP modeling of the seismic response of the fuel handling building is proper, in that the DCP has not adequately justified the use of the translational and torsional response of the auxiliary building as input to the fuel handling building nor has it demonstrated the validity of the dynamic degrees of freedom selected. (ITR 57.)"

Q.1: Did the IDVP verify that the ITP's modeling of the seismic response of the fuel handling building was proper?

A.1: Yes. This is reported in ITR-57.

Q.2: Did the ITP use translational and torsional response obtained from the auxiliary building analysis as input to the analysis of the fuel handling building?

A.2: Yes.

Q.3: Was it good engineering practice to use these auxiliary building responses as input to the analysis of the fuel handling building?

A.3: Yes. The fuel handling building was included in the model of the auxiliary building. A more detailed model of the fuel handling building was then used to determine local responses. The fuel handling building rests on the auxiliary building, and in an earthquake the excitation experienced by the fuel handling building will be the motion of the auxiliary building, as modeled by the ITP. This excitation includes both translational and torsional response.

Q.4: Were the appropriate dynamic degrees of freedom selected for the modeling of the fuel handling building?

A.4: Yes. The ITP developed a large comprehensive model for static analysis of the fuel handling building using the

Stardyne Computer Code. Following widely used engineering procedure, the large static model was divided into smaller parts and then condensed into two dynamic models with fewer degrees of freedom to make it manageable for dynamic analysis. The Guyan reduction technique in the Stardyne code, a reliable method which has been in standard use for many years, was used. A sufficient number of dynamic degrees of freedom was included to adequately determine peak accelerations. These peak accelerations were then used to obtain static loads which were applied to the large static model for purposes of member evaluation. The IDVP verified this process and the data transfer from dynamic models to static models (ITR-57, Section 4.2.4).

Q.5: In the judgement of the IDVP, were the modeling and analysis of the fuel handling building performed properly?

A.5: Yes.

CONTENTION 3.p. (RLC, JMB, MJH, RW)

"The ITP has not demonstrated, and the IDVP has not verified, that the DCP seismic model of the slabs in the auxiliary building is proper, in relation to the use of vertical and rotational springs to model the columns, and the motions used as input at the ends of the springs not connected to the slabs. In addition, in the study of the diaphragms, the ITP has not adequately accounted for the inplane flexibility of these slabs, and has not adequately demonstrated that stresses are within allowable limits at all elevations. (ITR 55.)"

Q.1: Did the IDVP verify ITP's modeling of slabs in the auxiliary building for the purpose of determining response of those slabs to vertical seismic inputs.

A.1: Yes, as reported in ITR-55.

Q.2: Why was it necessary for the ITP to model certain slabs in the auxiliary building and how was the modeling accomplished?

A.2: As reported in ITR-55, Rev. 1, the ITP performed calculations to determine which slabs had natural frequencies less than 33 Hz and therefore required more detailed modeling. Twelve such slabs were identified as requiring more detailed modeling to generate floor response spectra. This consisted of developing a finite-element model of the slab and using appropriate boundary conditions to represent the walls and supporting interior columns.

Q.3: In its analyses of the vertical response of auxiliary building slabs did the ITP incorporate in its models vertical and rotational springs to represent the supporting columns?

A.3: Yes. In addition, the ITP incorporated rotational springs to represent the supporting walls.

Q.4: What were the motions that the ITP input to the slab model?

A.4: Vertical motions at the slab elevation, obtained from the response of the auxiliary building as a whole to vertical ground motion, were input to the slab model.

Q.5: At what points on the model were the vertical motions input?

A.5: The motions described in A.4 were input to the slab at its wall boundaries, and to the grounded ends of the vertical springs representing the supporting columns.

Q.6: Did the IDVP verify that the details of modeling described in A.2 and A.3, and the choice and locations of input motion described in A.4 and A.5 were proper?

A.6: Yes. The IDVP verified that the modeling of the slab and the supporting columns, and the choice and locations of input motions were proper for the purpose of evaluating the vertical response of the slab. The IDVP conclusion is based upon the following considerations:

a) The vertical response of the slab is primarily a function of the stiffness characteristics and mass distribution of the slab itself, which are well represented by the finite element model of the slab.

b) Incorporating vertical springs, which represent the axial stiffness of the columns, is an appropriate refinement in the modeling of the slabs.

c) Based upon the differences in amplitude of motions at the floor elevation of the slab and at the elevations

one floor above and below, the choice of auxiliary input motions other than described in A.4 would not clearly represent a refinement.

Q.7: In the study of the diaphragms, did the ITP adequately account for the in-plane flexibility of the auxiliary building slabs?

A.7: Yes. The dynamic analysis was based on rigid diaphragms. A three-dimensional static finite element analysis, which included in-plane slab flexibility, was used for member evaluation. This is documented in ITR-55, Appendix E.

Q.8: Did the ITP adequately demonstrate in its analysis of the auxiliary building that stresses are within allowable limits at all elevations?

A.8: Yes. This was the purpose of the three-dimensional analysis cited in A.7.

Q.9: Does the IDVP conclude that the ITP used any improper modeling or methods of analysis in evaluating the auxiliary building as alleged in the contention?

A.9: No. Based on the sample reviewed by the IDVP, the ITP modeled and analyzed the slabs properly.

CONTENTION 3.q. (RLC, MJH, RW)

"The ITP has not demonstrated and the IDVP has not verified, that the soils analysis for the buried diesel fuel oil tanks is proper in that the values of the exponent shown in figure 14 of ITR 68 have not been demonstrated to be appropriate and the variation of shear velocity with depth is not properly justified. (ITR 68)".

Q.1: Did the IDVP verify that the ITP's soils analyses for the buried diesel fuel oil (DFO) tanks were proper?

A.1: Yes. The IDVP performed independent analyses and parametric studies on the DFO tanks. The ITP corrective action program performed similar studies. The IDVP verified that the ITP studies were correct and appropriate and in agreement with the IDVP independent analysis.

Q.2: Were the values of the exponents in ITR-68, Figure 14 the appropriate values?

A.2: The values of the exponents in the expressions for shear modulus plotted on Figure 14 of ITR-68 are judged to be acceptable. Studies by the IDVP demonstrated that the end results are not sensitive to values of the shear modulus.

Q.3: Did the ITP justify, and the IDVP verify, the variation in shear wave velocity with depth in the analysis of the buried DFO tanks?

A.3: Yes. The IDVP verified that the variation in shear wave velocity with depth for the rock used by the ITP was an acceptable representation of the data obtained from geophysical tests. It should be noted that the IDVP considers the axial (tangential) force in the tank wall to be the most important indicator of the extent of the demands exerted upon the tank. In none of the many cases investigated by the ITP and the IDVP did

this force exceed 40 percent of the elastic buckling strength of the tank with the soil resistance to tank buckling completely neglected. In reality the buckling resistance of a buried tank is substantially increased by the soil resistance to deformation. The IDVP believes that no credible changes in the assumed stiffness of the rock would lead to magnitudes of the tank axial force approaching the buckling strength.

Q.4: Does the IDVP believe that the ITP's soils modeling and analyses for the buried DFO tanks were appropriate?

A.4. Yes. The ITP's modeling and analyses performed to evaluate the DFO tanks were appropriate.

CONTENTION 3.r. (RLC, RW, MJH)

"The ITP has not demonstrated and the IDVP has not verified that the soils analysis for the auxiliary saltwater piping and circulating water intake conduit is proper in that the selection of the modulus versus strain curve utilized is not justified. (ITR 68.)"

Q.1: Has the IDVP verified that the modulus versus strain curve utilized in the ITP qualification of the auxiliary saltwater piping and circulating water intake conduit is justified?

A.1: Yes. As part of the IDVP's review summarized in ITR-68, Section 6.2.2, the IDVP verified that the form of the curve used follows an accepted approach and that it reflects test data which is tabulated on Figure 23 in that same ITR.

CONTENTION 3.s. (RLC, RW, JMB)

"The ITP has not demonstrated and the IDVP has not verified that the seismic analysis of the turbine building is proper in that bolt bearing capacities were taken from an inappropriate source. (ITR 56.)"

Q.1: Has the IDVP verified the ITP's use of bolt bearing capacities in its seismic analysis of the turbine building is proper?

A.1: Yes. The IDVP has verified the ITP's use of bolt bearing capacities as reported in ITR-56, Section 4.2.11.

Q.2: Did the ITP use appropriate bolt bearing capacities.

A.2: Yes. The turbine building is a Seismic Class 2 Structure. Therefore, the criterion in design is to protect the structure against collapse. Consequently, the turbine structural members, including steel member connections, are designed for the Hosgri earthquake on the basis of ultimate design strength. In determining the ultimate bearing capacity of certain bolts in the lower chord bracing connections, the ITP utilized a later edition of the AISC Code than referenced in the Hosgri Report. Based on test data (J.W. Fisher and J.H.A. Struik, "Guide to Design Criteria for Bolted and Riveted Joints," John Wiley & Sons, N.Y., 1974, p. 112), the actual bolt bearing capacities are greater than those derived from this later code. The IDVP is satisfied that the bolt bearing capacity used by the ITP is proper.

CONTENTION 3.t. (RLC, JMB, RW)

"The ITP has not demonstrated and the IDVP has not verified that the seismic analysis of the turbine building is proper in that the use of four different models for the vertical analysis has not been justified. (ITR 56.)"

Q.1: Has the IDVP verified that the ITR's use of four separate models for the vertical analysis of the turbine building is justified?

A.1: Yes. As reported in ITR-56, Sections 3.0 and 4.2.10, the IDVP found the use of four models is a reasonable way to determine the variation in response over the plan area. It should be noted that the vertical stiffness of the elements which connect the separate areas represented is small.

Q.2: How does one determine the proper number of models to use in evaluating a complex structure?

A.2: The choice of models depends on the configuration of the structure and the methods applied. The number of models is not as important as how they are used and the way conclusions are drawn from them.

Q.3: Was the ITP's analysis of the turbine building proper?

A.3: Yes. The analysis was proper.

CONTENTION 4.m. (RLC, RW)

"Contrary to QA program commitments in FSAR Section 17.1, documented evidence is inadequate to demonstrate that rupture restraints outside and inside containment have been properly designed and installed to provide protection against rupture in high pressure piping."

Q.1: Did the IDVP address the integrity of rupture restraints outside and inside containment?

A.1: The IDVP verified the structural integrity of rupture restraints outside containment. Rupture restraints inside containment were not within the scope of the IDVP as described in the IDVP Program Plan.

Q.2: What were the results of the IDVP review of rupture restraints outside containment?

A.2: In Phase II, the IDVP performed in-depth design reviews of the design and qualification of a sample consisting of 15 design review packages for rupture restraints, in addition to a review of the ITP program and methodology. These reviews are documented in ITR-65, Rev.1. The IDVP concluded that the design of the rupture restraints outside containment will meet the criteria of the licensing documents when the ITP program is complete.

Q.3: Did the IDVP accept any deviation from licensing criteria relating to the design of rupture restraints outside containment?

A.3: No. No such deviation exists.

CONTENTION 4.n. (MJH, RLC)

"For the containment exterior shell review the ITP review used the AISC Code rather than Section III of the ASME Code contrary to the commitment in Table 3.2-4 of the FSAR."

Q.1: Did the IDVP address the containment exterior shell qualification?

A.1: Yes.

Q.2: Did the ITP use the AISC code rather than Section III of the ASME code as required by the FSAR?

A.2: Contrary to the statement in the contention, Table 3.2-4 of the FSAR does not require the use of the ASME Code for the shell structure, only for certain portions. The IDVP did not verify the qualifications of all areas listed in Table 3.2-4 of the FSAR, since they were not in the IDVP sample. The IDVP did verify the qualification of the equipment hatch in the containment shell. For this item, the ITP used the ASME Code as required by Table 3.2-4. (ITR-54, Section 4.2.5).

Q.3: Has the IDVP accepted any deviations from licensing criteria in its verification of portions of the containment exterior shell qualification?

A.3: No.