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PG&E Letter DCL-10-066

10 CFR 50.90
10 CFR 50.59(c)(2)(viii)

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Diablo Canyon Units 1 and 2
Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
License Amendment Request 10-03, "Damping Values for the Seismic Design and Analysis of the Reactor Vessel Integrated Head Assembly"

Dear Commissioners and Staff:

Pursuant to 10 CFR 50.90, Pacific Gas and Electric (PG&E) hereby requests an amendment to Facility Operating License Nos. DPR-80 and DPR-82, for Diablo Canyon Power Plant (DCPP) Units 1 and 2, respectively, to allow revision of the licensing basis, as described in the Final Safety Analysis Report Update (FSARU), to include damping values for the seismic design and analysis of the integrated head assembly (IHA) that are consistent with the recommendations of Regulatory Guide (RG) 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," Revision 1. The RG 1.61, Revision 1, Table 1 note allowing use of a "weighted average" for design-basis safe-shutdown earthquake (SSE) damping values applicable to steel structures of different connection types is also applied to determine the IHA design-basis operating-basis earthquake (OBE) damping values.

The IHA is analyzed for the following DCPP design-basis seismic events: the Design Earthquake (DE), Double Design Earthquake (DDE), and the Hosgri Earthquake (HE). The DE and DDE correspond to the OBE and SSE as described in Appendix A to 10 CFR 100, respectively. The HE is also considered by the NRC to be the SSE. These relationships are discussed in FSARU, Section 3.7, and in NUREG-0675, "Safety Evaluation Report Related to the Operation of Diablo Canyon Nuclear Power Plant, Units 1 and 2," Supplement No. 7, Section 2.5.2 dated May 26, 1978.

Enclosure 1 includes a description of the proposed changes, the supporting technical analyses, and the no significant hazards consideration determination. Enclosure 2 includes additional information regarding the determination of the proposed damping values.

PG&E has determined that this license amendment request (LAR) does not involve a significant hazard consideration as determined per 10 CFR 50.92. Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment needs to be prepared in connection with the issuance of this amendment.

PG&E requests approval of this LAR by September 30, 2010, and that the license amendments be made effective upon NRC issuance, to be implemented within 30 days. The Unit 2 IHA was installed with the replacement reactor vessel closure head during the Unit 2 Fifteenth Refueling Outage in Fall 2009.

The proposed amendments have been reviewed by the Plant Staff Review Committee and approved by the Station Director. Pursuant to 10 CFR 50.91, a copy of this proposed amendment is being sent to the California Department of Public Health.

PG&E makes no regulatory commitments (as defined by NEI 99-04) in this letter. This letter includes no revisions to existing regulatory commitments.

If you have any questions or require additional information, please contact Tom Baldwin at (805) 545-4720.

I state under penalty of perjury that the foregoing is true and correct.

Executed on June 14, 2010.

Sincerely,

James R. Becker
Site Vice President

tcg5 SAPN50276288
Enclosures

cc: Diablo Distribution

cc/enc: Gary W. Butner, California Department of Public Health
Elmo E. Collins, NRC Region IV
Michael S. Peck, NRC, Senior Resident Inspector
Alan B. Wang, NRC Project Manager, Office of NRR

Evaluation of the Proposed Change

Subject: License Amendment Request 10-03, "Damping Values for the Seismic Design and Analysis of the Reactor Vessel Integrated Head Assembly"

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1. SUMMARY DESCRIPTION

This evaluation supports a request to amend Facility Operating License Nos. DPR-80 and DPR-82 for Diablo Canyon Power Plant (DCPP), Units 1 and 2, respectively, to revise the licensing basis, as described in the Final Safety Analysis Report Update (FSARU), to include damping values for the seismic design and analysis of the integrated head assembly (IHA) that are consistent with the recommendations of Regulatory Guide (RG) 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," Revision 1. The RG 1.61, Revision 1, Table 1 note allowing use of a "weighted average" for design-basis safe-shutdown earthquake (SSE) damping values applicable to steel structures of different connection types is also applied to determine the IHA design-basis operating-basis earthquake (OBE) damping values.

The IHA is analyzed for the following DCPP design-basis seismic events: the Design Earthquake (DE), Double Design Earthquake (DDE), and the Hosgri Earthquake (HE). The DE and DDE correspond to the OBE and SSE, as described in Appendix A to 10 CFR 100, respectively. The HE is also considered by the NRC to be the SSE. These relationships are discussed in FSARU, Section 3.7, and in NUREG-0675, "Safety Evaluation Report Related to the Operation of Diablo Canyon Nuclear Power Plant, Units 1 and 2," Supplement No. 7, dated May 26, 1978, Section 2.5.2.

2. DETAILED DESCRIPTION

Proposed Amendment

The proposed change would revise FSARU Section 3.7.1.3, "Critical Damping Values," to include the following damping values (percent of critical damping) for the IHA for the DE, DDE, and HE, respectively:

Type of Structure	Percent of Critical Damping		
	DE	DDE	HE
Integrated Head Assembly	4.9[g]	6.85[g]	6.85[g]

The following footnote would also be added to the damping values for the DE, DDE and HE:

[g]Damping values for the IHA are based on the recommendations in RG 1.61, Revision 1, Tables 1 and 2, using a weighted average for "Welded Steel or Bolted Steel with Friction Connections" and "Bolted Steel with Bearing Connections."

The proposed change would also add RG 1.61, Revision 1 to FSARU Section 3.7.7 as a reference.

Purpose for Proposed Amendment

RG 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," Revision 1 provides acceptable damping values to be used in the elastic dynamic seismic analysis and design of structures, systems, and components (SSCs), where energy dissipation is approximated by viscous damping unless otherwise specified.

The purpose of this proposed change is to obtain NRC approval for the use of damping values consistent with the recommendations of RG 1.61, Revision 1, for the seismic design and analysis of the IHA for the DE, DDE, and HE. The RG 1.61, Revision 1, Table 1 note allowing use of a "weighted average" for design-basis SSE (DDE and HE) damping values applicable to steel structures of different connection types, is also applied to determine the IHA design-basis OBE (DE) damping values.

RG 1.61, Revision 1, is not specifically described in the DCPP FSARU. Therefore, PG&E determined that the proposed change requires prior NRC approval as a departure from a methodology in accordance with 10 CFR 50.59(c)(2)(viii).

Risk-Informed Licensing Change

The requested change in the LAR is not a risk-informed licensing change.

3 TECHNICAL EVALUATION

System Description

The IHA (Figure 1) is primarily a bolted steel structure (with some welded connections) consisting of various components designed to provide cooling for the control rod drive mechanisms (CRDMs), radiation shielding for workers performing activities near the replacement reactor vessel closure head (RRVCH), seismic support for the CRDMs and other IHA components, and to facilitate lifting of the IHA and the RRVCH during refueling outages. The IHA is a new structure that does not have an existing equivalent. However, the IHA incorporates the functions of the former CRDM seismic support structure, the CRDM ventilation cooling system, and the head lift rig. The IHA consists of the following major components:

- Integral ductwork supplying exhaust fans for the CRDM air cooling system (NOTE: The ductwork forms part of the IHA structure and is not traditional round or rectangular sheet steel ducts such as described on Table 5 of

RG 1.61, Revision 1. Therefore, RG 1.61, Revision 1 damping values corresponding to steel structures are applied to those portions of the IHA that provide an air duct function.)

- Seismic support structure for the CRDMs and other IHA components
- Integral missile shield for postulated CRDM assembly missiles
- Lift rig for IHA/RRVCH lifting and movement
- Access ports for RRVCH nozzle inspection
- Radiation shielding above the RRVCH in the IHA lower shroud region
- Access ports for core exit thermocouple (CET) cable connections and other components
- Supports for CET cable trays
- Walkway for personnel access to IHA electrical cables and other components
- Cable bridges to route IHA electrical and instrumentation cables to bulkheads on the refuel floor

The above components are assembled together to form primarily a bolted steel structure that is bolted and pinned to the reactor vessel closure head. The IHA and RRVCH are lifted and moved as a single unit during refueling outages.

The seismic support structure assembly is an integral part of the IHA shroud assembly near the refueling floor elevation that provides lateral structural support for the IHA and CRDMs. Figure 2 shows the major components included in the seismic support structure assembly (some items that are attached to the support structure are excluded for clarity). The seismic support structure assembly includes eight seismic tie-rod restraints to transfer loads from the IHA and CRDMs to the cavity walls. Each tie-rod is pinned at both ends to connect the IHA to the reactor cavity concrete wall just below the refueling floor elevation.

The inner section of the IHA seismic support structure interfaces with the CRDM digital rod position indication (DRPI) plates and the filler plates through gaps between the outer row of plates and the inner section of the seismic support structure to maintain the original design concept to transfer loads from the CRDM, through the DRPI plates, to the seismic support structure by impact through the gaps. The outer section of the seismic support structure interfaces with the containment walls through seismic tie-rods to form a continuous load path in the horizontal direction to transfer loads from the CRDMs to the containment walls. For the rest of the IHA components, one load path is through the IHA support columns and through the seismic tie-rods into the containment wall. The other load path is through the IHA support columns and lift rods into the RRVCH.

Proposed Damping Values

The IHA seismic analyses were performed using 4.9 percent damping for the DE, 6.85 percent damping for the DDE, and 6.85 percent damping for the HE. These values correspond to the damping values contained in RG 1.61, Revision 1, for structures using a weighted average of the damping values corresponding to bolted bearing connections and welded connections. The damping values in RG 1.61, Revision 0, were previously considered acceptable for use in the re-evaluation of Design Class I structures for the HE during the licensing of DCPP, as discussed in NUREG-0675, Supplement No. 7, Section 3.8.5.3. Section 3.8.5.3 states:

> *"Allowing the use of higher damping values in this reevaluation is realistic and should not be regarded as an arbitrary lowering of the margins of safety. The values given in the Regulatory Guide have been acceptable for several years and are thus acceptable for this reevaluation."*

RG 1.61, Revision 1 updated the NRC guidance in RG 1.61, Revision 0, to incorporate the latest data and information, and reduce unnecessary conservatism in specification of damping values for seismic design and analysis of SSCs in nuclear power plants.

The various components of the IHA are generally connected with bolted bearing connections. However, the IHA includes a small number of welded connections. RG 1.61, Revision 0, does not provide damping value guidance for structures that include different types of connections. Therefore, the note on Table 1 of RG 1.61, Revision 1, was used that states: "For steel structures with a combination of different connection types, use the lowest specified damping value, or as an alternative, use a "weighted" average damping value based on the number of each type present in the structure." Since the IHA contains mostly bolted bearing connections, using the damping value associated with all connections being welded would be overly conservative. Therefore, the damping values associated with the weighted average of connection types were determined. The IHA connections that transfer a significant level of seismic inertia load were identified and categorized as either welded or bolted. Of 185 total significant load carrying connections, 9 connections are welded and the remaining 176 are bolted bearing connections. All pin connections are also conservatively treated as bolted bearing connections. These values were used to determine a weighted average 6.85 percent damping value for DDE and HE and a 4.9 percent damping value for DE. A discussion of the determination of the damping values is provided in Enclosure 2.

RG 1.61, Revision 1, Table 2 for OBE (DE) damping values does not contain the same note as found in Table 1 for SSE (DDE and HE) that describes how to address steel structures with different types of connections. However, use of the note for the determination of the DE damping value is consistent with the use of the note for the determination of the DDE and HE damping values, and a weighted average damping value more realistically represents the IHA structure.

All analysis results meet the acceptance criteria as described below.

IHA Seismic Analysis

A finite element structural analysis model was created for the IHA as depicted in Figure 3. Shell elements were used to model IHA plate components and beam elements were used to model IHA linear members such as columns and beams. The model included mass elements to represent the mass of components that were not explicitly included in the model such as the exhaust fans and pipe supports. The analysis model accounted for the tie-rod tension-only capability by adjusting the tie-rod stiffness for each of the three directions of seismic excitation such that modeled stiffness represents the stiffness associated with only the "active" tie-rods that resist applied loads in tension.

Seismic loads applied to the various components of the IHA were determined using the response spectrum analysis method. Response spectra inputs to the IHA seismic analyses were developed by enveloping the containment interior structure response spectra at the seismic support structure tie-rod elevation and the RRVCH spectra. Modal responses (displacements, accelerations, shears, moments, etc.) were combined by the square root of the sum of the squares (SRSS) method consistent with the DCPP current licensing basis (FSARU 3.7.2.1.3).

Due to the enveloping of the containment interior structure and RRVCH response spectra, the response spectra analysis method sometimes provided overly-conservative analysis results. To reduce unnecessary conservatism, selected seismic analyses were also performed using the time-history modal superposition method (FSARU 3.7.2.1.2). The time-history of response in each mode is determined from the acceleration time-history input by integration of the equations of motion. RRVCH time-history inputs are applied where the IHA connects to the RRVCH and Containment interior structure time-history inputs are applied where the IHA tie-rods connect to the building structure. The modal responses are combined by algebraic sum to produce an accurate summation at each time step (FSARU 3.7.2.1.2).

Modal mass participation exceeded 90 percent in each of the three directions of seismic loading (North-South, East-West, and vertical). For the DE and DDE seismic analyses, the responses due to the absolute summation of the responses due to the North-South and vertical seismic analyses were compared to those due to the absolute summation of the East-West and vertical seismic analyses and the maximum values of stress, load and displacement were used in the IHA evaluation. For the HE analysis, the responses due to the North-South, East-West and vertical seismic analyses were combined by the square root of the sum of the squares method to determine the stresses, loads and displacement for use in the IHA evaluation. The seismic analyses loads, stresses and displacements were combined with those due to other applicable loads such as deadweight and pressure to determine the total loads, stresses and displacements for the various components of the IHA.

The resulting IHA loads and stresses for DE, DDE, and HE were evaluated for acceptance using the ASME Boiler and Pressure Vessel Code, Section III, Division 1 – Subsection NF, "Component Supports," 2001 Edition through 2003 Addenda. All loads and stresses met acceptance limits. The complete IHA analysis includes hundreds of stress and load comparisons to allowable limits. The following table summarizes the IHA analysis results for the safety-related IHA connections and selected safety-related components with the largest stress ratios. The stress ratio is the calculated load or stress divided by the allowable value. Stress ratios equal to 1.0 represent an acceptable load or stress value with the required margin per applicable code, and stress ratios below 1.0 represent additional margin beyond that required by the applicable code. Tables 1 through 4 provide the member stress summaries for the controlling load combination. Table 5 provides a summary of the evaluation of connections between Design Class I (Seismic Class I) components.

<u>Summary</u>

A finite element structural analysis model was created for the IHA using critical damping values consistent with RG 1.61, Revision 1. The Table 1 note, allowing use of a "weighted average" for SSE damping values applicable to steel structures of different connection types, is also applied to the determination of OBE damping values. The IHA was evaluated for the following seismic events: DE, DDE, and HE. The DE corresponds to the OBE. The DDE and HE correspond to the SSE. The resulting IHA loads and stresses were evaluated for acceptance using the ASME Boiler and Pressure Vessel Code, Section III, Division 1 – Subsection NF, "Component Supports", 2001 Edition through 2003 Addenda. All loads and stresses met acceptance limits.

4. REGULATORY EVALUATION

4.1 <u>Applicable Regulatory Requirements/Criteria</u>

Regulatory Guide (RG) 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," Revision 1.

RG 1.61, Revision 1, specifies the damping values that the NRC staff currently considers acceptable for complying with the agency's regulations and guidance for seismic analysis. Revision 1 updated the NRC guidance for use in reviewing elastic modal (dynamic) seismic analysis of Seismic Category I SSCs. This revision incorporates the latest data and information, and reduces unnecessary conservatism in specification of damping values for seismic design and analysis of SSCs in nuclear power plants.

Section D, "Implementation," of Revision 1 states that "NRC staff will use the methods described in this guide to evaluate (1) submittals in connection with applications for construction permits, standard plant design certifications, operating licenses, early site permits, and combined licenses; and (2) submittals from operating reactor licensees who voluntarily propose to initiate system modifications if there is a clear nexus between the proposed modifications and the subject for which guidance is provided herein."

The proposed damping values for the seismic design and analysis of the IHA (4.9 for the DE, and 6.85 for the DDE and HE) are consistent with the recommendations of RG 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," Revision 1. The RG 1.61, Revision 1, Table 1 note allowing use of a "weighted average" for design-basis SSE damping values applicable to steel structures of different connection types is also applied to determine the design-basis OBE damping values. RG 1.61, Revision 1, Table 2 for OBE (DE) damping values does not contain the same note as found in Table 1. However use of the note for the determination of the DE damping value is consistent with the use of the note for the determination of the DDE and HE damping values, and a weighted average more realistically represents the IHA structure.

4.2 <u>Precedent</u>

RG 1.61, Revision 1, is referenced in the Vogtle Electric Generating Plant, Units 3 and 4, Combined Operating License Application, Part 2, FSAR, Revision 0, dated March 23, 2008, and in NUREG-1923, "Safety Evaluation Report for an Early Site Permit (ESP) at the Vogtle Electric Generating Plant (VEGP) ESP Site," dated July 2009.

4.3 <u>No Significant Hazards Consideration</u>

The proposed change would revise the licensing basis as documented in the Final Safety Analysis Report Update (FSARU) to specify critical damping values consistent with Regulatory Guide (RG) 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," Revision 1, dated

March 2007, for the seismic design and analysis of an integrated head assembly (IHA). The RG 1.61, Revision 1, Table 1 note allowing use of a "weighted average" for design-basis safe-shutdown earthquake (SSE) damping values applicable to steel structures of different connection types, is also applied to determine the IHA design-basis operating-basis earthquake (OBE) damping values. For the Diablo Canyon Power Plant, the Design Earthquake (DE) and the Double Design Earthquake (DDE) correspond to the OBE and SSE as described in Appendix A to 10 CFR 100, respectively. The Hosgri Earthquake (HE) is also considered by the NRC to be the SSE.

The IHA, installed with a replacement reactor vessel closure head (RRVCH), is primarily a bolted steel structure (with bolted bearing connections and some welded connections) consisting of various components designed to provide cooling for the control rod drive mechanisms (CRDMs), radiation shielding for workers performing activities near the RRVCH, seismic support for the CRDMs and other components, and to facilitate lifting the RRVCH and IHA during refueling outages. The IHA is a new structure that does not have an existing equivalent. However, the IHA incorporates the functions of the former CRDM seismic support structure, the CRDM ventilation cooling system, and the head lift rig.

PG&E has evaluated whether or not a significant hazards consideration is involved with the proposed amendment by focusing on the three standards set forth in 10 CFR 50.92, "Issuance of amendment," as discussed below:

1. *Does the change involve a significant increase in the probability or consequences of an accident previously evaluated?*

The proposed change would allow use of critical damping values consistent with the recommendations of RG 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," Revision 1, dated March 2007, for the seismic design and analysis of the IHA. The RG 1.61, Revision 1, Table 1 note allowing use of a "weighted average" for design-basis SSE damping values applicable to steel structures of different connection types, is also applied to determine the IHA design-basis OBE damping values. RG 1.61, Revision 1, Table 2 for OBE damping values does not contain the same note as found in Table 1. However use of the note for the determination of the DE damping value is consistent with the use of the note for the determination of the DDE and HE damping values, and a weighted average more realistically represents the IHA structure.

RG 1.61, Revision 1, specifies the damping values that the NRC staff currently considers acceptable for complying with the agency's regulations and guidance for seismic analysis. Revision 1 incorporates the latest data and information, and reduces unnecessary conservatism in specification of damping values for seismic design and analysis of SSCs.

The proposed change does not change the design functions of the IHA or its response to design-basis events, nor does it affect the capability of related SSCs to perform their design or safety functions. The use of the proposed damping values in the seismic design and analysis of the IHA is related to the ability of the IHA to function in response to design-basis seismic events, and is unrelated to the probability of occurrence of those events, or other previously evaluated accidents. Therefore the proposed change will not have any impact on the probability of an accident previously evaluated.

The proposed damping values are an element of the seismic analyses performed to confirm the ability of the IHA to function under postulated seismic events while maintaining resulting stresses within ASME Section III allowable values. Therefore, the use of damping values consistent with the recommendations of RG 1.61, Revision 1 does not result in an increase in the consequences of accidents previously evaluated.

Therefore, the proposed change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. *Does the change create the possibility of a new or different kind of accident from any accident previously evaluated?*

The proposed change does not involve changes to any plant SSCs, nor does it involve changes to any plant operating practice or procedure. The damping values are an element of the seismic analyses performed to confirm the ability of the IHA to function under postulated seismic events while maintaining resulting stresses within ASME Section III allowable values. Therefore, no credible new failure mechanisms, malfunctions, or accident initiators not considered in the design and licensing bases are created that would create the possibility of a new or different kind of accident.

Therefore the proposed change does not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. *Does the change involve a significant reduction in a margin of safety?*

The design basis of the plant requires structures to be capable of withstanding normal and accident loads including those from a design basis earthquake. The proposed change would allow the use of damping values in the IHA seismic analyses that are in general more realistic and, thus, more accurate than the damping values recommended in RG 1.61, Revision 0, used in the analysis for the HE, or the plant specific damping values used in the original analysis for the DE and DDE. The NRC stated, in NUREG-0675, "Safety Evaluation Report Related to the Operation of Diablo Canyon Nuclear Power Plant, Units 1 and 2," Supplement No. 7, that allowing use of the higher damping values in RG 1.61, Revision 0 for the HE re-evaluation, versus the lower values used in the original analysis, is realistic and should not be regarded as an arbitrary lowering of the margins of safety. The damping values in RG 1.61, Revision 0, were based on limited data, expert opinion, and other information available in 1973. NRC and industry research since 1973 show that the damping values provided in the original version of RG 1.61 may not reflect realistic damping values for SSCs. RG 1.61, Revision 1, therefore, provides damping values based on the updated research results that predict and estimate damping values for seismic design of SSCs in nuclear power plants, and similarly should not be regarded as an arbitrary lowering of the margins of safety.

As discussed above, damping values are an element of the seismic analyses performed to confirm the ability of the IHA to function during design-basis seismic events while maintaining resulting stresses within ASME Section III allowable values. The proposed change ot allow use of damping values consistent with the recommendations of RG 1.61, Revision 1, versus the damping values in the current licensing basis could result in lower calculated stresses. The analysis done for the IHA using the proposed damping values showed the ASME Section III allowable values are met. Sufficient safety margins are maintained when Codes and standards or alternatives approved for use by the NRC are met.

Therefore, the proposed change does not involve a significant reduction in a margin of safety.

Based on the above evaluation, PG&E concludes that the change proposed by this license amendment request (LAR) satisfies the no significant hazards consideration standards of 10 CFR 50.92(c), and accordingly a no significant hazards finding is justified.

4.4 Conclusions

In conclusion, based on the considerations discussed above: (1) There is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

5. ENVIRONMENTAL CONSIDERATION

PG&E has evaluated the proposed amendment and has determined that the proposed amendment does not involve: (1) a significant hazards consideration, (2) a significant change in the types or significant increase in the amounts of any effluents that may be released offsite, or (3) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

6 REFERENCES

1. Regulatory Guide 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," Revision 1, March 2007

2. Regulatory Guide 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," Revision 0, October 1973

3. NUREG-0675, "Safety Evaluation Report Related to the Operation of Diablo Canyon Nuclear Power Plant, Units 1 and 2," Supplement No. 7, dated May 26, 1978

4. Vogtle Electric Generating Plant, Units 3 and 4, Combined Operating License Application, Part 2, FSAR, Revision 0, March 23, 2008

5. NUREG-1923, "Safety Evaluation Report for an Early Site Permit (ESP) at the Vogtle Electric Generating Plant (VEGP) ESP Site," July 2009

6. Final Safety Analysis Report Update, Revision 19

Table 1

Member Stress Summary for Controlling Load Combination
Design Class I / Seismic Category I Linear Components

Component Description	**Controlling Load Combination**	**Stress Ratio**
Support Columns	DL + P +/- srss(DDE+LOCA)	0.85
Lift-Rods	DL + P +/- srss(DDE+MI)	0.96
Bottom Ring Beam	DL + P +/- srss(DDE+LOCA)	0.54
Seismic Support Beam	DL + P + T +/- DE	0.26
Seismic Ring Beam	DL + P +/- srss(DDE+LOCA)	0.51
Seismic Reinforced Beam	DL + P +/- DE	0.28
Duct Support in Mid/Upper Shroud	DL + P +/- srss(DDE+LOCA)	0.30
Angle connecting Duct Sections	DL + P +/- DE	0.73
Cable Support Ring Beam	DL + P +/- HE	0.37
Cable Bridge Longitudinal Tube in Foldable Section	DL + P +/- srss(DDE+LOCA)	0.92
Cable Bridge Lateral Tube in Foldable Section	DL + P +/- srss(DDE+LOCA)	0.76
Cable Bridge Vertical Tube and Wing Frame in Foldable Sect.	DL + P +/- srss(DDE+LOCA)	0.48
Bridge Lifting Mech. Horizontal Support Tube	DL + P +/- srss(DDE+LOCA)	0.66
Bridge Lift-Mechanism Tube	DL + P +/- srss(DDE+LOCA)	0.38

Component Description	**Controlling Load Combination**	**Stress Ratio**
Cable Bridge Support Tube under Missile Shield	DL + P +/- srss(DDE+LOCA)	0.54
CET Vertical Trays	DL + P +/- srss(DDE+LOCA)	0.15
CET Vertical Tray Support Bracket	DL + P +/- HE	0.40
Seismic Bar (Tie-Rod Lug)	DL + P +/- srss(DDE+LOCA)	0.17
Seismic Tie-Rod Bracket	DL + P +/- srss(DDE+LOCA)	0.49
Seismic Tie-Rod Tube	DL + P +/- HE	0.84
Pipe Rod Connecting Cable Bridge & Lift-Mechanism	DL + P +/- srss(DDE+LOCA)	0.66
Support Tube under Walkway at Bridge	DL + P +/- srss(DDE+LOCA)	0.67
Seismic Tie-Rods	DL + P +/- srss(DDE+LOCA)	0.53

Table 2

Member Stress Summary for Controlling Load Combination
Design Class I / Seismic Category I Plate Components

Component Description	Controlling Load Combination	Stress Ratio
Missile Shield	DL + P +/- DE	0.38
Seismic Support Plate on Seismic Ring Beam	DL + P +/- DE	0.37
Stiffener Plate on Bottom Ring Beam	DL + P +/- DE	0.52
CRDM DRPI Plates	DL + P +/- srss(DDE+LOCA)	0.34
Support Bracket connecting Monorail & Walkway to Column	DL + P + ML	0.81
Walkway Plate away from Bridges	DL + P +/- srss(DDE+LOCA)	0.22
Walkway Plate Edge Stiffener	DL + P +/- DE	0.36
Walkway Plate under Bridges	DL + P + ML	0.35
Cable Bridge Vertical Supp Plates in Stationary Section	DL + P +/- DE	0.95
Cable Bridge Support Cross Plates in Stationary Section	DL + P +/- DE	0.61
Cable Bridge Support Plates in Foldable Section	DL + P +/- DE	0.68

Table 3

Member Stress Summary for Controlling Load Combination
Design Class II / Seismic Category II/I Linear Components

Component Description	Controlling Load Combination	Stress Ratio
Angle Beams at Boundary of each Assembly	DL + P +/- DDE	0.75
Tripod Rods	DL + P +/- DDE	0.23
Monorail	DL + P + ML	0.88
Baffle Support Beam	DL + P +/- DDE	0.35
Stiffener at CET Doors & Windows in Duct	DL + P + T	0.36
Fan Support Top Horizontal Tee Ring	DL + P +/- DDE	0.52
Fan Support Vertical Tube	DL + P +/- DDE	0.80
Stiffener at Base of Duct	DL + P +/- HE	0.61
Baffle Cover Support Angle	DL + P +/- HE	0.17
Plenum Center Column	DL + P +/- DDE	0.31
Angle Frame for Plenum	DL + P + ML	0.35
Angle Attached to Duct at Top	DL + P +/- DDE	0.45
Angle Stiffener for Ducts	DL + P +/- DDE	0.35
Cable Bundle Supports	DL + P +/- DDE	0.32
Plenum Angle attached to MS	DL + P +/- DDE	0.30
Vertical Angle Stiffener to Duct	DL + P +/- DDE	0.17
Vertical Angle Stiffener to Duct	DL + P +/- HE	0.43

Component Description	Controlling Load Combination	Stress Ratio
Baffle Support Link	DL + P +/- HE	0.31
Fan Support Bottom Ring	DL + P +/- DDE	0.39
Monorail End Supp Bracket	DL + P + ML	0.22

Table 4

Member Stress Summary for Controlling Load Combination
Design Class II / Seismic Category II/I Plate Components

Component Description	**Controlling Load Combination**	**Stress Ratio**
Baffle	DL + P +/- HE	0.35
Stiffener Plate at top of Baffle	DL + P +/- DDE	0.29
Radiation Shield Doors	DL + P +/- HE	0.17
Lower Assy Shroud Panels	DL + P +/- DDE	0.27
Mid Assy Shroud Panels	DL + P +/- HE	0.16
Lower Assy Duct	DL + P +/- DDE	0.43
Baffle Cover	DL + P +/- HE	0.51
Mid Assy Duct	DL + P +/- DDE	0.29
Upper B Assy Shroud Panels	DL + P +/- HE	0.20
Upper B Assy Duct	DL + P +/- DDE	0.40
Upper A Assy Shroud Panels	DL + P +/- HE	0.33
Upper A Assy Duct	DL + P +/- DDE	0.48
CET Access Doors in Lower Assy Duct	DL + P +/- DDE	0.09
Plenum Cover Plates	DL + P + ML	0.29
Plenum Top Panels	DL + P +/- DDE	0.11
Plenum Side Panels	DL + P +/- DDE	0.50

Table 5

Summary of Evaluation of Connections between Design Class I (Seismic Category I) Components

Connection Number	Connection Description / Controlling Component	Controlling Load Combination	Max. Stress Ratio
SCN-01	Connection of Seismic Tie-Rods: Tie Rod Lug Mounting Bolts	DL+P+T+/-DE	0.58
SCN-02	Connection of Lift-Rod Clevis to RRVCH Lug: Pin	DL+P+T+/- srss(DDE+MI)	0.21
SCN-03	Connection of Bottom Ring Beam to Intermediate Pads: Bolts	DL+P+T+/-DE	0.53
SCN-04	Connection of Bottom Ring Beam to Clevis of Lift-Rod: Bolt Bearing / Edge Distance	DL+P+T+/- srss(DDE+LOCA)	0.48
SCN-05	Connection of Stiffener Plate and Bottom Ring Beam: Weld	DL+P+/- srss(DDE+LOCA)	0.79
SCN-06	Connection of Columns to Bottom Ring Beam: Base Plate	DL+P+T+/ srss(DDE+LOCA)	0.86
SCN-07	Lower Splice Connection of Columns: Bolt Bearing / Edge Distance	DL+P+T+/- srss(DDE+LOCA)	0.68
SCN-08	Mid Splice Connection of Columns: Bolt Bearing / Edge Distance	DL+P+T+/-HE	0.60
SCN-09	Upper Splice Connection of Columns: Bolt Bearing / Edge Distance	DL+P+T+/- srss(DDE+LOCA)	0.73
SCN-10	Connection of Bridge Support Tubes Under Walkway to Seismic Ring: CJP Weld – no evaluation	n/a	n/a
SCN-11	Connection of Tangential Tie-Rod Tubes to Outer Bridge Support Tubes: Weld	DL+P+T+/- srss(DDE+LOCA)	0.88

Connection Number	Connection Description / Controlling Component	Controlling Load Combination	Max. Stress Ratio
SCN-12	Connection of Tangential Tie-Rod Tubes to Inner Bridge Support Tubes: Weld	DL+P+T+/- srss(DDE+LOCA)	0.86
SCN-13	Connection of Bridge Support Tubes Under Walkway to Walkway: Weld	DL+P+T+/-DE	0.89
SCN-14	Connection of Seismic Ring Beam to Columns: Weld	DL+P+T+/- srss(DDE+LOCA)	0.76
SCN-15	U-Bolt Connection of Lift-Rods to Ring Angles: U-bolt Bolt Bearing / Edge Distance	DL+P+T+/- srss(DDE+LOCA)	0.26
SCN-16a	Connection of Walkway to Support Brackets, 90 & 270 Deg. Loc Bolts	DL+P+T+/-DE	0.33
SCN-16b	Connection of Walkway to Support Brackets, 30, 150, 210, 330 Deg. Loc: Bolts	DL+P+T+/-DE	0.85
SCN-17	Connection of Walkway Support Brackets to Columns: Bolt Bearing / Edge Distance	DL+P+T+/- srss(DDE+LOCA)	0.49
SCN-18	Connection of Cable Bridge Support to Walkway: Bolts	DL+P+T+/-DE	0.97
SCN-19	Connection of Bridge Support Vertical Cross Plate to Vertical Side Plates: Weld	DL+P+T+/- srss(DDE+LOCA)	0.72
SCN-20	Connection of Bridge Support Top Horizontal Cross Plate to Side Plates: Weld	DL+P+T+/- srss(DDE+LOCA)	0.78
SCN-21	Connection of Bridge Support Bottom Horizontal Cross Plate to Side Plates: Weld	DL+P+T+/- srss(DDE+LOCA)	0.88
SCN-22	Connection of Bridge Support Horizontal Cross Plate to Vertical Cross Plate: Weld	DL+P+T+/- srss(DDE+LOCA)	0.19

Connection Number	Connection Description / Controlling Component	Controlling Load Combination	Max. Stress Ratio
SCN-23	Connection of Bridges to Stationary Supports (Pivot): Shaft	DL+P+T+/-DE	0.97
SCN-24	Connection of Bridge Lateral Tubes to Longitudinal Tubes: Weld	DL+P+T+/-HE	0.92
SCN-25a	Connection of Bridge Vertical Tubes to Longitudinal Tubes: Weld	DL+P+T+/-srss(DDE+LOCA)	0.78
SCN-25b	Connection of Bridge Vertical Tubes to Longitudinal Tubes: Weld	DL+P+T+/-srss(DDE+LOCA)	0.88
SCN-26	Connection of Bridge Wing Frame Lateral & Diagonal Tubes to Main Frame: Weld	DL+P+T+/-srss(DDE+LOCA)	0.68
SCN-27	Connection of Bridge Wing Frame Long. & Diagonal Tubes to Lateral Tubes: Weld	DL+P+T+/-srss(DDE+LOCA)	0.27
SCN-28	Connection of Bridge Wing Frame Vertical Tubes to Lateral Tubes: Weld	DL+P+T+/-srss(DDE+LOCA)	0.30
SCN-29	Connection of Cable Bridge Link Pipes: Lug Plate (axial + bending)	DL+P+T+/-DE	0.86
SCN-30a	Connection of Bridge Lifting Mechanism Support Tubes to Tube Rings: Weld	DL+P+T+/-srss(DDE+LOCA)	0.86
SCN-30b	Connection of Bridge Lifting Mechanism to Support Tubes: Weld	DL+P+T+/-srss(DDE+LOCA)	0.82
SCN-31	Connection of Cable Support Tube Rings to Columns: Bolt Bearing / Edge Distance	DL+P+/-HE	0.64
SCN-32	Connection of Upper A Top Tube Ring to Columns: Bolts	DL+P+T+/-DE	0.46

Connection Number	Connection Description / Controlling Component	Controlling Load Combination	Max. Stress Ratio
SCN-33	Connection of Adjusting Disks to Seismic Reinforced Beam: Bearing Between Disc and Screw	DL+P+T+/-srss(DDE+LOCA)	0.45
SCN-34	Connection of Missile Shield Alignment Pins to Top of Columns: Weld	DL+P+T+/-srss(DDE+LOCA)	0.68
SCN-35	Connection of Missile Shield to Lift-Rods: Leveling Nut (thread engagement verified)	n/a	n/a
SCN-36	Connection of Seismic Plates to Seismic Ring Beam & Inner Beam: Weld	DL+P+T+/-srss(DDE+LOCA)	0.40
SCN-37	Connection of CET Vertical Trays to Support Brackets: Weld	DL+P+T+/-HE	0.10
SCN-38	Connection of CET Vertical Trays Support Brackets to Duct Support Brackets: Base Plate	DL+P+T+/-HE	0.95
SCN-39	Connection of Mid & Upper B Duct to Support Brackets: Weld of Support Bracket to Base Plate	DL+P+T+/-srss(DDE+LOCA)	0.62
SCN-40	Connection of Mid & Upper B Duct Support Brackets to Columns: Weld of Support Bracket to Base Plate	DL+P+T+/-srss(DDE+LOCA)	0.68

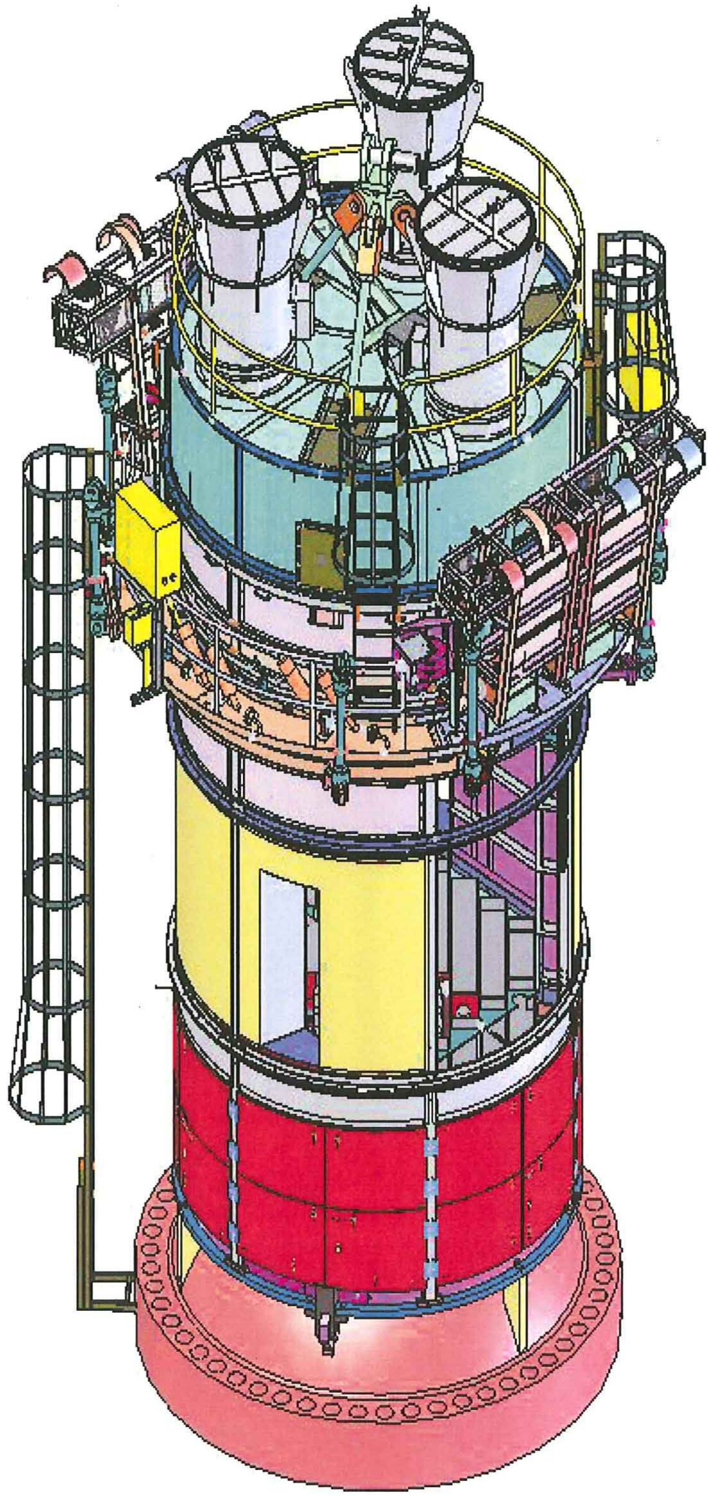
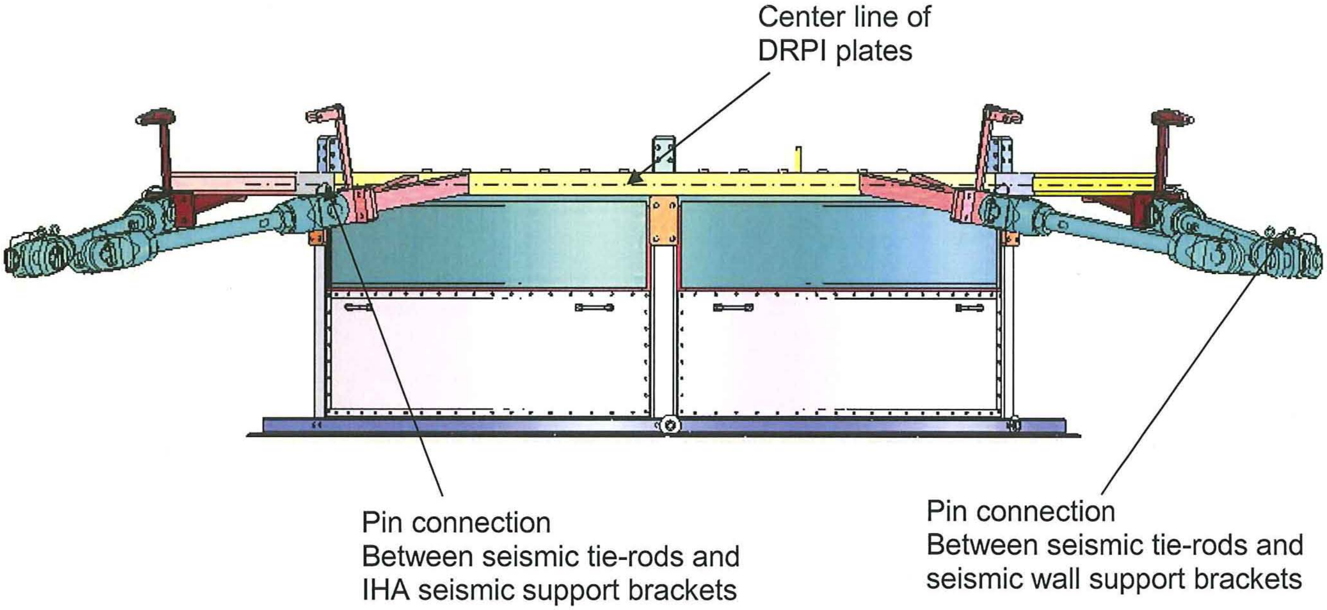


Figure 1: Replacement Reactor Vessel Closure Head with Integrated Head Assembly



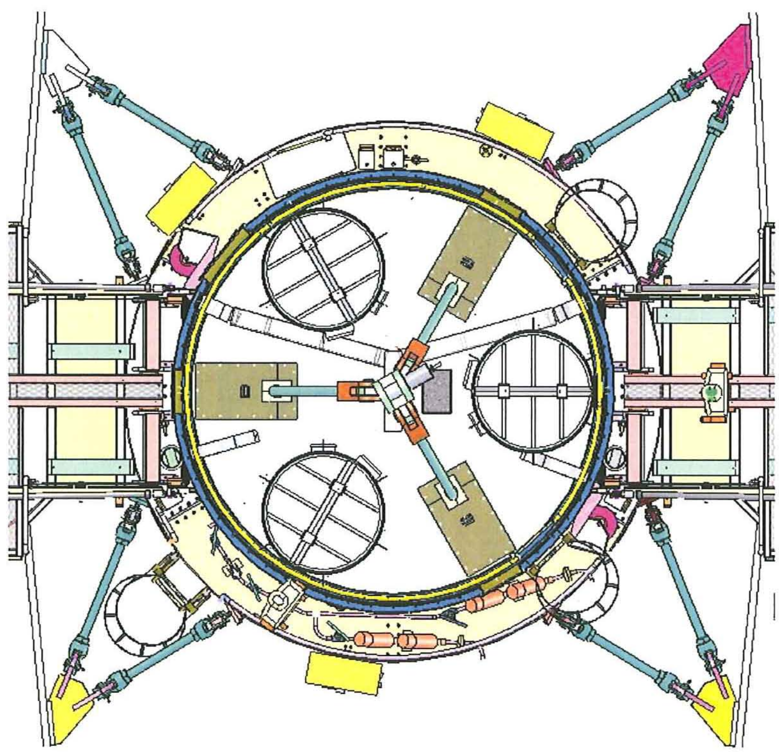


Figure 2: Seismic Support Structure Assembly

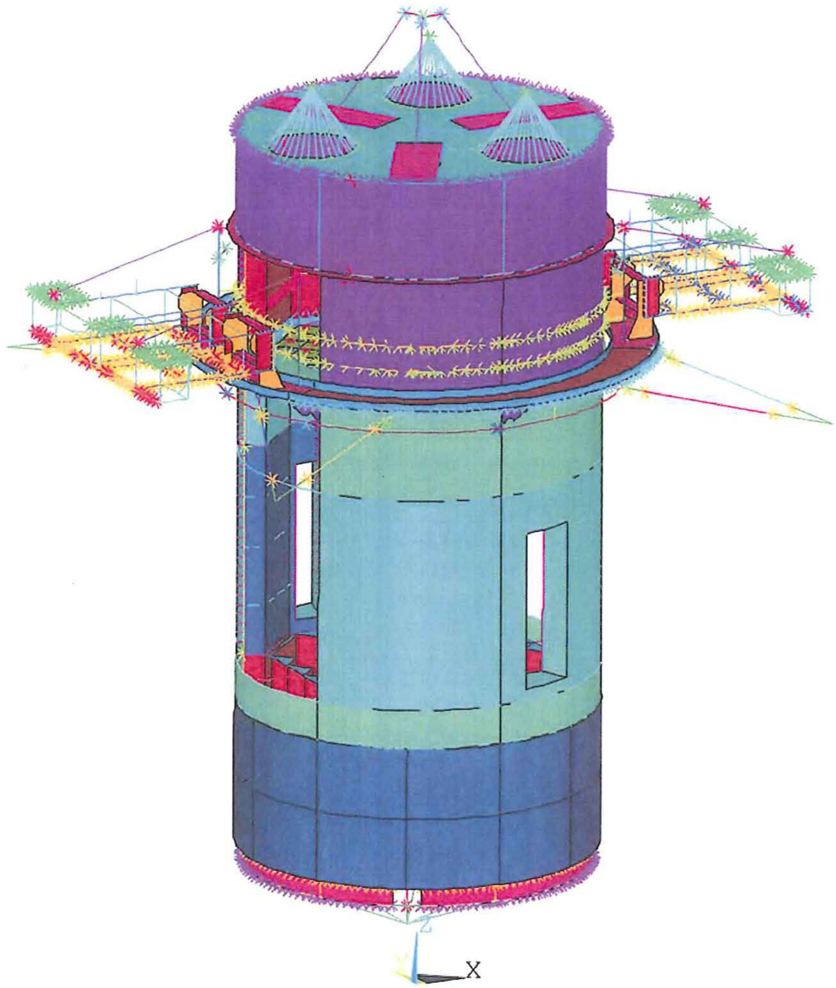


Figure 3: IHA Structural Analysis Model

Damping Values for Use in the Integrated Head Assembly Seismic Response Analysis at Diablo Canyon Power Plant (DCPP) Units 1 and 2

Document No. 06042TR-04
Rev. 4

DAMPING VALUES FOR USE IN THE INTEGRATED HEAD ASSEMBLY SEISMIC RESPONSE ANALYSIS

AT

DIABLO CANYON POWER PLANT (DCPP) UNITS 1 AND 2

A WHITE PAPER

PRESENTED TO

PACIFIC GAS AND ELECTRIC COMPANY

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Revision Summary

Rev. No.	Description	Affected Pages
0	Initial Issue	All
1	Signatures were missing in Rev. 0. They were added in Rev. 1; List of References was added; A damping value was corrected.	Cover page, Page 2, 3, 6
2	Modifications to the Table 1 list of major connections in the IHA to reflect the IHA's final design. Incorporation of the computation of a "weighted" damping value for the IHA, based on a new Table 2. Incorporation of drawings of the connections identified in Table 2.	All
3	Revised to incorporate the results from the IHA response spectrum analysis using USM method. "ADVENT Proprietary" was removed from the header, and the proprietary statement was removed (sheet 2 of the previous revision). Editorial changes were made.	All, except Attachment A. Content changes are indicated by revision bars.
4	Incorporated AREVA and PG&E comments. Clarified Note 1 to Table 2 regarding the total number of connections identified at the bottom of Table 2.	All, except Attachment A. Content changes are indicated by revision bars.

DAMPING VALUES FOR USE IN THE INTEGRATED HEAD ASSEMBLY SEISMIC RESPONSE ANALYSIS

INTRODUCTION

The ADVENT/AREVA team is designing an Integrated Head Assembly (IHA) as a replacement structure for the existing reactor vessel head service structure at Diablo Canyon Units 1 and 2. An isometric view of the IHA is provided in Figure 1 and its plan view in Figure 2. The concept of integrating all the removable upper reactor vessel head components into one removable structure is the object of this design. However, functionality of each head component is maintained in the integrated head assembly.

The IHA is a steel structure that provides required support for the CRDM cooling components, CRDM seismic components, CRDM missile shield structure, CRDM cooling fans, reactor vessel head lift rig structure, and for the head area cable routing. The IHA is a four-story high (approximately 43 feet tall) steel structure and has more than 10,000 parts assembled together by bolted and welded connections. The number of bolted connections is significantly larger than the number of welded connections in the IHA. In addition, all bolted connections in the IHA are bearing connections with specified snug-tight requirements. The IHA has no friction type bolted connections. The bolted and welded connections that are potentially critical for the transfer of loads and the dissipation of energy during a seismic event are listed in Table 1. The types of connection listed in Table 1 occur at numerous locations within the IHA.

This white paper identifies the damping requirements for response spectrum analyses of steel structures such as IHA, per the guidance of Regulatory Guide 1.61, Revision 1. Based on the presence of critical connections in the IHA that are the primary source of dissipating seismic energy, this white paper presents the computation of "weighted" damping values for the IHA, based on the recommendations of the NRC Regulatory Guide 1.61, Revision 1.

REGULATORY GUIDE 1.61 REVISION 1 REQUIREMENTS FOR DAMPING

For bolted steel with bearing connections, Regulatory Guide 1.61, Revision 1 provides 5.0% and 7.0% damping values for the OBE and SSE earthquakes respectively (for DCPP, the Design Earthquake (DE) is equivalent to an OBE; the Double Design Earthquake (DDE) is equivalent to an SSE; the Hosgri Earthquake (HE) is an additional SSE equivalent earthquake). Section 3.7.1.3 of the Diablo Canyon FSARU, where critical damping values are discussed, is applicable to Design Class I systems, structures, and components (Safety Related and Seismic Category I) and Design Class II turbine building and intake structure. Since the integrated head assembly is an assembly of Design Class I components, as well as Design Class II/I components (Non Safety Related and Seismic Category II/I), and is considered a support of the reactor coolant loop components (CRDM support), it is considered that this section of the FSARU is applicable to the IHA.

Bolted connections which transmit load are categorized in the Regulatory Guide as either "friction-type" or "bearing-type". The "friction-type" connection depends upon high clamping force to prevent slip of the connected parts under anticipated service conditions. This clamping force is developed by pre-torquing the bolt to a tension typically equal to 70% of its ultimate strength, and special surface preparation may be specified on the bearing members so as to achieve high friction force. This connection behaves more like a welded connection under the anticipated service loads. The "bearing-type" connection depends upon contact of the fastener shank against the sides of their holes to transfer the load from one connected part to another. With relatively easy slip between the joined members, the energy dissipation capacity of a "bearing-type" connection is much higher than that of the "friction-type" connection.

The NRC issued Regulatory Guide 1.61, Revision 1 in March 2007. Regulatory Guide 1.61, Revision 1 differentiates between a welded steel or bolted steel with friction connections and a bolted steel with bearing connection based on the differences in their energy absorbing capabilities. Per Regulatory Guide 1.61, Revision 1, the damping values for welded steel or bolted steel with friction connections are 3.0% for the Operating Basis Earthquake (OBE) and 4.0% for the Safe Shutdown Earthquake (SSE). The damping values for bolted steel with bearing connections are 5.0% for the OBE and 7.0% for the SSE.

Regulatory Guide 1.61, Revision 1 requires that for steel structures with a combination of different connections, either the lowest specified damping value for the connections in the combination be used or a "weighted average" damping value, based on the number of each type of connection present in the structure, be computed.

Table 1 lists different types of major connections in the IHA and identifies whether they are welded connections or bolted connections. Welded connections of components of assemblies listed in Table 7-78 and 7-79 of 06042TR-03, that are connected via bolts or pins to other major components of the IHA were excluded from Table 1, since the bolts/pins provide the major source of damping. Energy dissipation through a pin connection is addressed as it is for a bearing type bolted connection; a pin connection has a similar value of damping as does a bearing type bolted connection, based on the clearances provided in the pin-to-hole dimensions.

DISCUSSION ON TYPES OF CONNECTION

The integrated head assembly does not have any friction type connections. All bolted connections in the IHA are bearing type specified as being snug-tight. However, the IHA includes a small number of welded connections.

Table 2 lists those of the IHA connections listed in Table 1 which transfer a significant level of inertia load during a seismic event. The table includes a description of each connection, referenced drawing(s) that depict the connection, the type of each connection and the quantity of each connection type. The table identifies only 9 welded connections. Certain of the welded connections listed in Table 1 are not included in Table 2 and are, therefore, not included in the calculation of the IHA's "weighted" damping value. These welds include:

- **Connection 4: Bottom Ring Beam Stiffener to Bottom Ring Beam**
  The bottom ring beam stiffeners are welded to the bottom ring beam with a two sided weld (¾" fillet & ¾" bevel weld). The ring beam, along with the stiffeners, is considered to be one composite member and hence, it is concluded that this welded connection need not be considered as a component connection for the calculation of the weighted average.

- **Connection 17: Connecting Plate to the Upper/Lower Shroud Segments**
  The connecting plates are welded to the upper/lower shroud segments to provide surfaces where the shroud panels can be welded or bolted. As discussed for Connection 19 below, there is little load transferred through these plates and, hence, it is concluded that this connection is not significant in dissipating energy.

- **Connection 19: Shroud Panels to Columns**
  The IHA seismic analysis results show that the stresses are low (maximum stress ratio less than 0.50). In addition, the shroud panels are only 0.12 inches thick. This low stress ratio in the thin shroud panels indicates that there is little load transfer from support columns to the shroud panels through the welded connection and, hence, it is concluded that this connection is not significant in dissipating energy.

- **Connection 34: Support Column Alignment Pins to Support Columns**
  The support column alignment pin assemblies are CJP welded to the support columns. Since the weld is a CJP weld, these assemblies are considered to be an integral part of the columns.

- **Connection 39: Air Plenum Base Angle to Air Plenum**
  The air plenum base angle is welded to the air plenum to form a flange at the bottom of the air plenum to enable it to be bolted to the missile shield. The bolted connection between this angle and the missile shield is the critical connection in transferring loads from the air plenum to the missile shield. Hence, it is concluded that this welded connection need not be considered in the calculation of the weighted average.

Attachment A contains drawings that depict and identify the connections, as numbered in Table 2.

Further, the integrated head assembly is a vertically standing structure bolted to three support lugs on the replacement reactor vessel head (RRVCH) and pinned to three lift lugs on the reactor vessel head. In addition to these six attachment points on the RRVCH, there are eight seismic tie rods pinned to the IHA seismic ring beam at the refuel floor elevation. On the cavity wall side, these tie rods are pinned to wall lugs that are an integral part of plates that are bolted to the containment wall. All eight seismic tie rod connections on both ends of the tie rods are pin connections (See Figures 1 and 2).

"WEIGHTED" DAMPING VALUES FOR IHA RESPONSE SPECTRUM ANALYSIS

As shown in Table 2, there are a total of 185 connections in the IHA which transfer a significant level of inertia load. Among these connections, there are a total of 9 welded connections and 176 bearing - bolted / pinned connections. Based on these quantities, the "weighted average" is calculated as below

For OBE:

(3% x 9 + 5% x 176) / (9+176) = 4.90%

For SSE:

(4% x 9 + 7% x 176) / (9+176) = 6.85%

The calculated weighted average damping value of 4.90% for the OBE (DE) is used in the IHA seismic analysis. The calculated weighted average damping value of 6.85% for the SSE (DDE and Hosgri) is used in the IHA seismic analysis.

REFERENCES

1. Pacific Gas and Electric Company (PG&E), Diablo Canyon Power Plant Units 1 and 2 FSAR Update.
2. Nuclear Regulatory Commission, Regulatory Guide 1.61, Revision 1, March, 2007, Damping Values for Seismic Design of Nuclear Power Plants.

Figure 1: Integrated Head Assembly - Isometric View

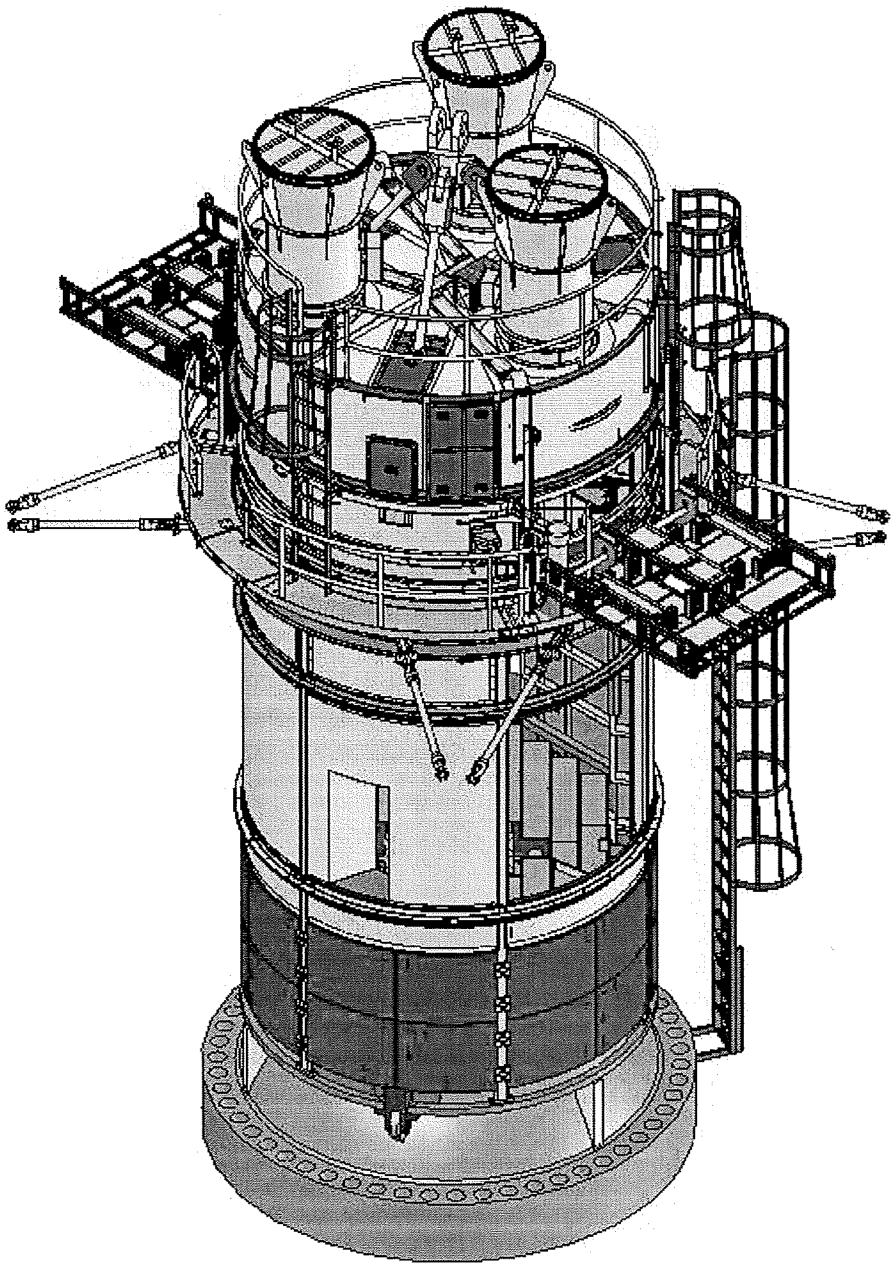

Figure 2: Integrated Head Assembly – Plan (Top) View

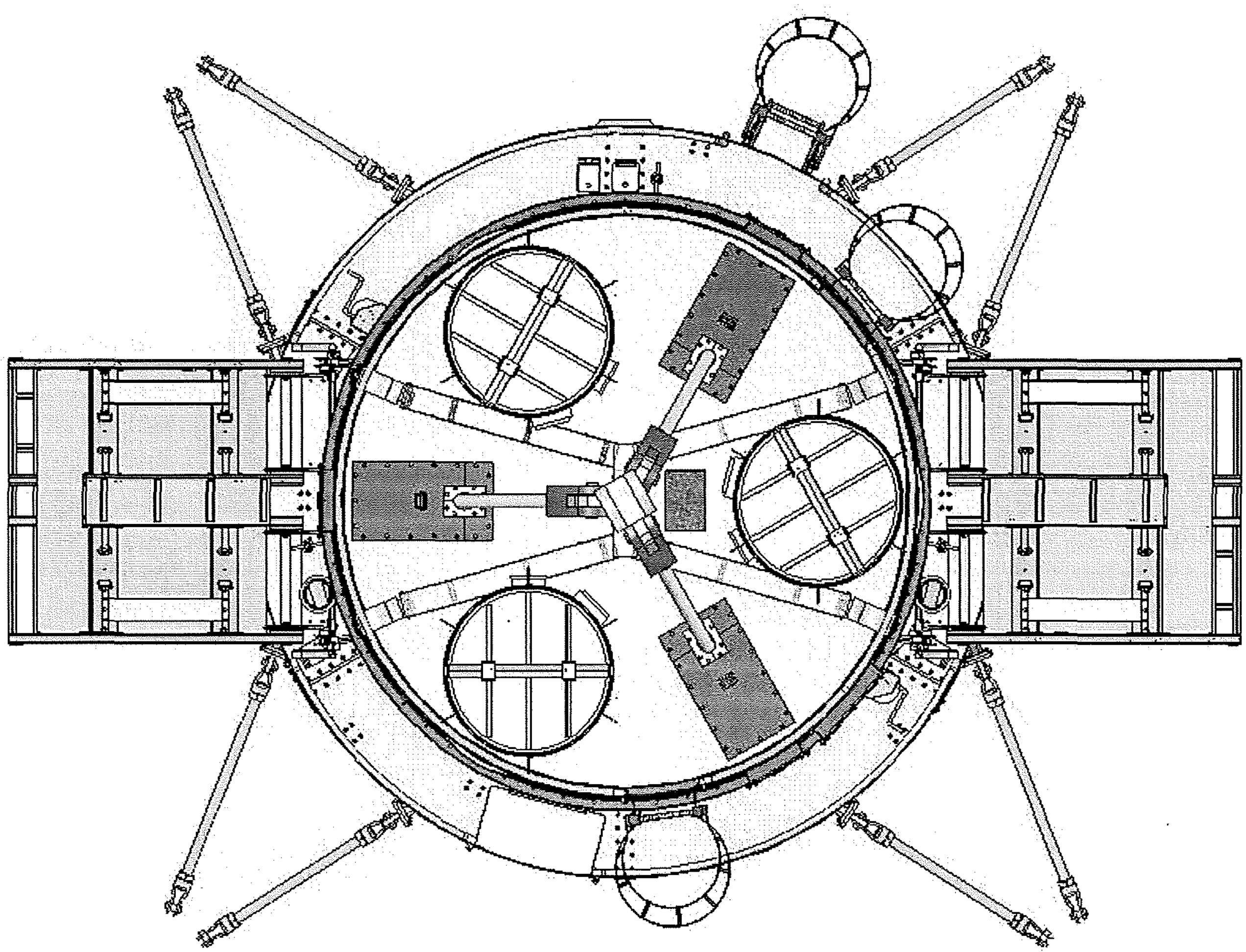

Table 1: A List of Major Connections in the IHA

	Connection Description	Welded Connection	Bolted-Bearing or Pin Connection
	Design Class I and Seismic Category I Components (Safety Related)		
1	Seismic Tie Rods to Seismic Ring Beam/ Tie Rods Brackets (Pin)		√
2	Lift Rod Clevis to RRVCH Lift Lug (Pin)		√
3	Bottom Ring Beam to Lift Rod Clevis		√
4	Bottom Ring Beam Stiffener to Bottom Ring Beam	√	
5	Support Columns to Bottom Ring Beam	√(1)	√ (1)
6	Support Column Splice Connections		√
7	Seismic Tie Rod Bracket Mounting Plate to Seismic Ring Beam/Tie Rods Brackets		√
8	Seismic Ring Beam to Support Columns	√	
9	Lift Rod Clevis to Lift Rod		√
10	Lift Rod Leveling Nut to Lift Rod		√
11	Seismic Tie Rod Clevis to Cavity Wall Lug (Pin)		√
12	Lift Rod Lift Nut to Lift Rod		√
13	U-Bolt Connection between Lift Rod & Shroud Angles		√
14	CRDM Seismic (DRPI)Plates to Seismic Reinforced Ring		√
15	Seismic Wall Brackets to Wall		√(2)
16	Bottom Ring Beam to IHA Support Lugs on the RRVCH		√
	Design Class II and Seismic Category II/I Components (Non Safety Related)		
17	Connecting Plate to the Upper/Lower Shroud Segments	√	
18	Upper Section A Removable Shroud Panels to Columns		√

	Connection Description	Welded Connection	Bolted-Bearing or Pin Connection
19	Shroud Panels to Columns	√	
20	Shroud Subassembly Angles to Support Columns		√
21	Angles to Angles between Shroud Subassemblies		√
22	Baffle to Baffle		√
23	Baffle Support to Support Columns		√
24	Radiation Shield Door Support Angle to Support Column		√
25	Radiation Shield Doors to Support Columns (Hinge)		√
26	Air Ducts to Support Columns		√
27	Air Duct Sub Assembly to Sub Assembly		√
28	Messenger Wire Support Ring Tube to Support Columns		√
29	Monorail Support Bracket to Support Columns		√
30	Monorail to Monorail Support Bracket		√
31	Monorail Support Bracket to Walkway		√
32	Cable Bridge to Walkway		√
33	Cable Bridge Stationary Section to Foldable Section		√
34	Support Column Alignment Pins to Support Columns	√	
35	Tripod Leg Upper Clevis to Tripod Lift Eye (Pin)		√
36	Lift Block to Missile Shield		√
37	Tripod Leg Lower Clevis to Lift Block		√
38	Air Plenum Base Angle to Missile Shield		√
39	Air Plenum Base Angle to Air Plenum	√	
40	Cooling Fan to Cooling Fan Support		√

	Connection Description	Welded Connection	Bolted-Bearing or Pin Connection
41	Cooling Fan Support to Missile Shield		√
42	Missile Shield to Support Column (Pin)		√
43	Radiation Shield Door Latches		√
44	Cable Bridge Link Assembly to Cable Bridge (Pin)		√
45	RVLIS and RVHVS Support to Support Column		√
46	RRVCH Insulation Support To Bottom Ring Beam		√

Notes:

(1) Connection 5 of each support column to the bottom ring beam is a hybrid connection, which transfers load through a combination of the weld between the bottom ring beam vertical stiffener plates and the column and through the bolted connection between the column base plate and the bottom flange of the bottom ring beam.

(2) The seismic wall brackets are beyond the scope of the IHA; they are analyzed and evaluated by AREVA.

Table 2: List of Connections which Transfer a Significant Level of Inertia Load During a Seismic Event

Connection No.	Connection Description	Reference Drawings	Type of Connection[3]	QTY
1	Seismic Tie Rods to Seismic Ring Beam / Tie Rods Brackets (Pin)	06042-M-172, Sheet 1	Pinned	8
2	Lift Rod Clevis to RRVCH Lift Lug (Pin)	06042-M-201, Sheet 1	Pinned	3
3	Bottom Ring Beam to Lift Rod Clevis	06042-M-051, Sheet 2	Bolted	6
5	Support Columns to Bottom Ring Beam	06042-M-053, Sheet 1 & 06042-M-052, Sheet 1	Bolted & *Welded*	3 [4] 3[4]
6	Support Column Splice Connections	06042-M-005, Sheet 2	Bolted	36
7	Seismic Tie Rod Bracket Mounting Plate to Seismic Ring Beam / Tie Rods Brackets	06042-M-171, Sheet 1	Bolted	8
8	Seismic Ring Beam to Support Columns	06042-M-151, Sheet 1	*Welded*	6
9	Lift Rod Clevis to Lift Rod	06042-M-201, Sheet 1	Bolted	3
10	Lift Rod Leveling Nut to Lift Rod	06042-M-201, Sheet 1	Bolted	3[1]
11	Seismic Tie Rod Clevis to Cavity Wall Lug (Pin)	06042-M-172, Sheet 1	Pinned	8
12	Lift Rod Lift Nut to Lift Rod	06042-M-201, Sheet 1	Bolted	3 [1]
15	Seismic Wall Brackets to Wall	06042-M-175, Sheet 1	Bolted	4 [2]
16	Bottom Ring Beam to IHA Support Lugs on the RRVCH	06042-M-051, Sheet 2	Bolted	3

Connection No.	Connection Description	Reference Drawings	Type of Connection(3)	QTY
21	Angles to Angles between Shroud Subassemblies	06042-M-005, Sheet 1	Bolted	3
22	Baffle to Baffle	06042-M-061, Sheet 1	Bolted	2
23	Baffle Support to Support Columns	06042-M-062, Sheets 1 & 2	Bolted	24
25	Radiation Shield Doors to Support Columns (Hinge)	06042-M-055, Sheet 1 & 06042-M-056, Sheet 1	Pinned	24(5)
43	Radiation Shield Door Latches	06042-M-058, Sheets 1 & 2	Bolted	
32	Cable Bridge to Walkway	06042-M-250, Sheet 1	Bolted	4
33	Cable Bridge Stationary Section to Foldable Section	06042-M-251, Sheets 1 & 2	Pinned	4
35	Tripod Leg Upper Clevis to Tripod Lift Eye (Pin)	06042-M-203, Sheet 1	Pinned	3
36	Lift Block to Missile Shield	06042-M-203, Sheet 1	Bolted	3
37	Tripod Leg Lower Clevis to Lift Block	06042-M-203, Sheet 1	Pinned	3
38	Air Plenum Base Angle to Missile Shield	06042-M-005, Sheet 1	Bolted	1
40	Cooling Fan to Cooling Fan Support	06042-M-330, Sheet 1	Bolted	3
41	Cooling Fan Support to Missile Shield	06042-M-302, Sheet 1	Bolted	3
42	Missile Shield to Support Column (Pin)	06042-M-180, Sheet 1, 06042-M-182, Sheets1 – 4 & 06042-M-206, Sheet 1	Pinned	6

Connection No.	Connection Description	Reference Drawings	Type of Connection(3)	QTY
44	Cable Bridge Link Assembly to Cable Bridge (Pin)	06042-M-251, Sheets 1 & 2	Pinned	8
			Total	185 (1)

Notes:

(1) The missile shield is restrained in the vertical direction; by the lift nuts against upward motion (Connection 12), and by the leveling nuts against downward motion (Connection 10). Only either the lift nuts or the leveling nuts are addressed in the determination of effective connections in the load path from the IHA missile shield component to the RVCH in the vertical direction. Therefore, the total number of connections of 185 considers a total of 3 for Connections 10 and 12.

(2) The seismic wall brackets are beyond the scope of the IHA; they are analyzed and evaluated by AREVA.

(3) All bolted connections are bearing connections.

(4) Connection 5 of each support column to the bottom ring beam is a hybrid connection, which transfers load through a combination of the weld between the bottom ring beam vertical stiffener plates and the column and through the bolted connection between the column base plate and the bottom flange of the bottom ring beam. This connection transmits most components of load and moment through the bolted connection, e.g. radial load, moment about the tangential axis, and moment about the vertical axis. Due to the contribution of dead load in minimizing tension loading in the column, relatively little vertical load is transferred through either the weld or the bolted connection. Owing to the nature of this connection, each of the components of the connection have been "weighted" by halving their number (while there are six such connections, only 3 welds and 3 bolted connections have been considered).

(5) For Connection No. 25, Radiation Shield Doors to Support Columns, the net effect of the two hinges and the latches (Connection No.43) is conservatively considered to be only one connection per door (24 doors).