SAFETY EVALUATION REPORT

Docket No. 72-26
Pacific Gas & Electric Company
Materials License No. SNM-2511
Amendment No. 1

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1 SUMMARY

By letter dated April 7, 2008, as supplemented September 1, November 23, December 31, 2009, and January 22, 2010, Pacific Gas and Electric Company (PG&E) submitted license amendment request (LAR) 08-001 to the United States Nuclear Regulatory Commission (NRC) to amend Materials License SNM-2511 for the for the Diablo Canyon Independent Spent Fuel Storage Installation (ISFSI) in accordance with 10 CFR Part 72. The Diablo Canyon ISFSI utilizes the Holtec HI-STORM 100 cask storage system, which employs multi-purpose canisters placed inside overpacks to safely store the spent nuclear fuel.

LAR 08-001 proposed the following revisions to the technical specifications (TS):

1.1 Clarification of the required helium leak rate condition and the leak rate testing requirements of TS 3.1.1, "Multi-Purpose Canister (MPC),"

1.2 Elimination of TS 3.1.4, "Spent Fuel Storage Cask (SFSC) Time Limitation in Cask Transfer Facility (CTF),"

1.3 Revision of TS 3.2.1, "Dissolved Boron Concentration," to modify the dissolved boron concentrations required for MPC-32 canisters and to allow linear interpolation for some fuel enrichments,

1.4 Revision of TS 3.2.1 to add a note to both surveillance requirements to limit the monitoring requirement,

1.5 Revision of TS 4.1, "Design Features Significant to Safety," to allow use of Metamic as a neutron absorber,

1.6 Revision of TS 4.3.4.a, "Permanent Load Handling Equipment," to change the title to "Weldment and Reinforced Concrete,"

1.7 Clarification of TS 4.3.4.b, "Mobile Load Handling Equipment," by identifying the "permanent load handling equipment" as "the cask transporter," and

1.8 Clarification of the requirements of TS 5.1.3, "MPC and SFSC Loading, Unloading, and Preparation Program" with regards to the maintenance conditions in the annular gap between the MPC and the transfer cask during the moisture removal process.

2 BACKGROUND

The Diablo Canyon ISFSI is co-located with the Diablo Canyon Power Plant (DCPP) on PG&E-owned property, located on the California coast approximately 10 km [6 mi] northwest of Avila Beach, California. The DCPP consists of two nuclear-generating units, each having a spent fuel pool to store spent nuclear fuel generated from reactor operation. The Diablo Canyon ISFSI provides additional spent nuclear fuel storage capacity to DCPP beyond 2006, when the wet pool storage was near full capacity. Where applicable, the Diablo Canyon ISFSI Final Safety Analysis Report (FSAR) utilizes site-specific information previously presented in the DCPP FSAR.

The two reactor units of DCPP share a common fuel-handling building and auxiliary building as well as components of auxiliary systems. Each unit has a dedicated fuel-handling system and spent nuclear fuel pool. Both units share a single 125 ton-[113,398 kg]-capacity crane for fuel handling activities. Each reactor core contains 193 fuel assemblies, and both units are currently operating on 18 to 21 month refueling cycles. Typically, 76 to 96 spent nuclear fuel assemblies are permanently discharged from each unit during a refueling.

The Diablo Canyon ISFSI is designed to hold up to 140 storage casks. Based on the current fuel strategy and the principal use of the multi-purpose canister (MPC) that contains a maximum of 32 pressurized water reactor fuel assemblies (MPC-32), the Diablo Canyon ISFSI is capable of storing all of the spent nuclear fuel generated by the two DCPP reactors during the terms of their current operating licenses. The Diablo Canyon ISFSI consists of the Holtec HI-STORM 100 cask storage system, a Cask Transfer Facility (CTF), an onsite cask transporter, and the storage pads. In addition, to accommodate spent nuclear fuel generated during the ISFSI licensed period, as well as any damaged fuel assemblies, debris, and nonfuel hardware, PG&E may use three other MPC designs from the HI-STORM 100 Cask System, including the MPC-24, MPC-24E, and MPC-24EF designs. All four MPC designs use the same storage overpack. The HI-STORM 100 Cask System has also been approved for use by general licensees under Certificate of Compliance (CoC) No. 1014.

The Diablo Canyon HI-STORM 100 Cask System license issued March 22, 2004, was evaluated using CoC No. 1014, Amendment No. 1 as the primary licensing basis. HI-STORM 100 Final Safety Analysis Report (FSAR) Rev. 1A provided the supporting documentation, design, and operations information to support the staff's CoC No. 1014, Amendment No. 1 evaluation, and it contained language allowing Holtec to modify and evaluate changes to component sizes to allow for specific spent fuel storage applications. It was PG&E's interpretation that the MPC-32 and associated transfer cask licensed under SNM-2511 could be modified under the provisions of 10 CFR 72.48 which did not require NRC approval prior to implementation. At the time of the amendment application on April 7, 2008, PG&E informed the staff of its intent to modify the MPC-32 and associated transfer cask, and that a summary of this modification would be provided in its Biennial FSAR update in June 2008. It also informed the staff that this modification was not part of LAR 08-001 since it was being performed under the provisions of 10 CFR 72.48. In its June 26, 2008, letter to the NRC, PG&E did provide brief descriptions of the modifications to the MPC-32 and the associated transfer cask.

In LAR 08-001 PG&E referred to Holtec International Report No. HI-2053376, "Thermal-Hydraulic Analysis for Diablo Canyon Site-Specific HI-STORM System Design," Revision 5, dated February 5, 2008, as a supporting calculation. This calculation was originally performed to evaluate the thermal-hydraulic performance of the modifications to the Diablo Canyon ISFSI system that were being performed under the provisions of 10 CFR 72.48. Modifications included

reducing the height of the MPC-32 and the associated HI-STORM 100 HI-TRAC transfer canister by approximately 9 inches (See table below). The staff requested a copy of the latest revision to Report No. HI-2053376 and other applicable design documents and calculations for these modifications for reference purposes. PG&E provided these in its letter to the NRC dated December 31, 2009.

Although the staff did not directly evaluate the modifications to the Diablo Canyon ISFSI performed under the provisions of 10 CFR 72.48, LAR 08-001 was submitted using these modifications as a primary basis for the request. Modifications to the MPC-32 are summarized in the table below.

Overall Height	Reduced by 9”
Internal Cavity Height	Reduced by 9”
Fuel Basket Height	Reduced by 14”
Closure Lid	1-7/8” X 5” C-channels mounted on bottom surface

The PGE process used to perform 10 CFR 72.48 and integrate ISFSI modifications into FSAR design bases appears to be appropriate. However the staff did not explicitly evaluate the changes against the 10 CFR 72.48 criteria or requirements of Part 72 for accident conditions, as part of this licensing action. The validity of the 10 CFR 72.48 change is subject to NRC inspection.

3 REVIEW CRITERIA

The staff's evaluation of the proposed changes are based on ensuring PG&E continues to meet the applicable requirements of 10 CFR Part 72 for independent storage of spent fuel and of 10 CFR Part 20 for radiation protection. The staff utilized the guidelines provided in NUREG-1567, “Standard Review Plan for Spent Fuel Dry Storage Facilities” in conducting its evaluation. The staff’s evaluation focused only on changes to SNM-2511 and associated TS requested in the application and did not reassess previously approved portions of the license, TS, and the FSAR or those areas of the FSAR modified by PG&E as allowed by 10 CFR 72.48. The technical objectives for the following review disciplines are as described below for each of the proposed changes.

4 SSC AND DESIGN CRITERIA EVALUATION

The proposed changes do not impact the original SSC and design criteria evaluation. Therefore an evaluation was not required.

5 STRUCTURAL EVALUATION

The following proposed revisions are applicable to the structural evaluation:

PG&E proposed the title of TS 4.3.4.a, "Permanent Load Handling Equipment", be revised to "Weldment and Reinforcement Concrete." (Proposed revision 1.6)

PG&E also proposed to revise TS 4.3.4.b, "Mobile Load Handling Equipment", by identifying the "permanent load handling equipment" as "the cask transporter." (Proposed revision 1.7)

These revisions do not affect any structural features of any system.

The staff finds that the revision of title for TS 4.3.4.a to "Weldment and Reinforced Concrete" is adequate and of no detriment to structural performance. Likewise, the staff finds that the revision of TS 4.3.4.b, identifying "Mobile Load Handling Equipment" as "cask transporter", is of no structural concern, and therefore is acceptable.

6 THERMAL EVALUATION

6.1 REVIEW OBJECTIVE

The objective of the thermal evaluation is to confirm that the decay heat removal system remains capable of reliable operation so that the temperatures of materials used for systems, structures, and components (SSCs) important to safety and fuel assembly cladding material remain within the allowable limits under normal, off-normal, and accident conditions that may be affected by LAR 08-001.

The following proposed revisions are applicable to the thermal evaluation.

TS 3.1.4; "Spent Fuel Storage Cask (SFSC) Time Limitation in Cask Transfer Facility (CTF)," is proposed to be eliminated (Proposed revision 1.2). PG&E requested elimination of the TS based on a site-specific analysis of the thermal performance of a modified HI-STORM 100 Cask System that shows there is no need for a required time limitation in CTF.

TS 5.1.3; "MPC and SFSC Loading, Unloading, and Preparation Program," is proposed to be revised to clarify the required maintenance of water conditions in the annular gap between the MPC and the HI-TRAC transfer cask during the drying process. (Proposed revision 1.8) PG&E requested this revision based on the previous approval of forced He dehydration in which water is not required.

The original thermal licensing basis for SNM-2511 is provided from the design and thermal performance of the HI-STORM 100 Cask System evaluated in CoC No. 1014, Amendment No. 1. PG&E modified the cask system under 10 CFR 72.48 as described in Safety Evaluation Report (SER), Section 2. Because the thermal performance of the system is influenced by the revised design characteristics, the staff requested PG&E provide thermal and confinement analyses based on the revised design to evaluate LAR08-001. Given potential uncertainties in the analytical approach used by Holtec in CoC No. 1014, Amendment No. 1, and the pressure safety margins associated with the modified Diablo Canyon HI-STORM MPC-32, the staff requested PG&E to re-perform the blocked-vent thermal accident analyses using the more accurate analytical approach consistent with previously approved CoC No. 1014, Amendment No. 5. PG&E provided Holtec Report HI-2053376, Rev. 7, dated January 10, 2010, to demonstrate the thermal performance of the modified HI-STORM 100 Cask System. The staff evaluated the thermal performance of the modified system pertaining to the proposed removal of the CTF time limit in TS 3.1.4 considering the thermal accident events associated with complete blockage of vents and potential failure of cladding. The staff did not otherwise evaluate or explicitly approve the design or performance of the modified HI-STORM 100 Cask System under normal, off-normal, and accident conditions, as part of LAR 08-001.

6.2 EVALUATION

6.2.1 Revision of TS 5.1.3

PG&E proposed to remove the word “water” in TS 5.1.3(b) to clarify the annular gap water condition during drying process. The original approval of SNM-2511 allowed the use of either

vacuum drying (VD) or forced helium dehydration (FHD) to remove moisture from the canister. The VD process requires water to be full in the annual gap between the outside surface of MPC and the inner surface of transfer cask to cool the MPC, and the water must be continuously provided for heat loads greater than 20.8 kW. However, PG&E indicated this is not required for FHD and the efficiency of the process can be reduced with water in the annual gap according to the approved analysis. Because both VD and FHD methods are approved processes for the moisture removal for low burnup fuel (≤45,000 MWD/MTU), PG&E can apply either method depending on the heat load.

The current TS 5.1.3 requires water present in the annular gap for any drying process, but FSAR section 10.2.2.1 requires no water requirements for FHD process. Since TS 5.1.3 refers to the annular gap water requirements in FSAR 10.2.2.1, specifying "water" in TS 5.1.3 is not consistent with FSAR 10.2.2.1. Therefore, PG&E proposed to remove the word "water" in TS 5.1.3. The staff finds this acceptable because both VD and FHD are acceptable methods for moisture removal as limited in the FSAR, and the request makes the annular gap water requirement be consistent between TS 5.1.3 and FSAR 10.2.2.1. Therefore the staff revised the TS 5.1.3(b) to clarify that water in the annular gap is required when using VD for canister drying operations under approved heat loads, and that water is not allowed when using FHD. This is an administrative change and is consistent with the Diablo Canyon ISFSI FSAR.

6.2.2 Revision of TS 3.1.4

PG&E proposed to revise the time limit in TS 3.1.4 for the condition of equipment lift failure that prevents a HI-STORM overpack from being removed from CTF. Under this off-normal event, the flow of air to the bottom inlet vents would be restricted.

PG&E performed a steady-state evaluation to predict the maximum fuel cladding temperature, the cask components temperatures, and the MPC internal pressure. In previous calculations, PG&E had established 1058ºF and 214.7 psia as the allowable design-basis limits for off-normal events. PG&E provided results for the modified HI-STORM 100 Cask System that were below the allowable limits under off-normal events to support the requested revision.

The staff evaluated the resulting thermal performance of temperature and pressure in Tables 2-9 and Figures D.1 and D.2 of HI-2053376, Rev. 7, for credible design basis events. The staff found that the proposed change does not affect the thermal performance criteria, including 1) maintaining the fuel cladding integrity and 2) ensuring that component temperature and MPC internal pressure are below the allowable design-basis limits of 1058ºF and 214.7 psia, respectively. Therefore, the staff finds the proposed revision of TS 3.1.4, in compliance with 10 CFR 72.24(d), 72.122(b), 72.122(h)(1) and 72.128(a)(4) acceptable.

6.2.2.1 Thermal Performance in the CTF

Holtec Report HI-2053376, Rev. 7, was provided as the thermal analysis and licensing bases for revising TS 3.1.4 in LAR 08-001. PG&E identified the modified MPC-32 as the bounding component of three different MPC designs (MPC-24, MPC-24E, and MPC-32) authorized by SNM-2511. PG&E indicated that the modified MPC-32 provided the highest design-basis decay heat load, provided the highest cask system component and contents temperatures, and the highest MPC internal pressures.

The CTF TS in the original license was based on the thermal performance of an MPC-32 with a longer axial length consistent with the design evaluated in CoC No. 1014, Amendment No. 1. The Diablo Canyon ISFSI was modified as described in SER, Section 2. Because the canister

length influences thermal and confinement performance, the staff evaluated the thermal performance of the modified systems with respect to the proposed request for removal of the CTF time limit in TS 3.1.4, along with thermal accident events associated with complete blockage of vents and potential failure of cladding.

6.2.2.2 Thermal Methodology for the Blocked Vent Analyses

Methodology of Computer Model

PG&E used a two-part modeling approach with separate models of MPC-32 and the overpack. These two component models are manually coupled through the outer surface of the MPC shell that is included in both component models. PG&E characterized the gas circulation inside the MPC as laminar flow because of low velocities based on Reynolds and Rayleigh numbers calculated for the MPC operating conditions. They then applied a k-□ turbulence model (with the transitional option enabled) to characterize the air flow through the annular gap between MPC and overpack. Therefore, the air flow in the inlet and outlet vents, and annular gap between MPC and concrete inner shell was in the transitional regime. This approach was consistent with the approach used in CoC No. 1014, Amendment No. 5, previously approved by NRC.

PG&E modeled the fuel assembly flow resistance using two hydraulic resistance parameters, permeability and inertial resistance factor, for the porous media used to represent the loaded fuel basket in the MPC that is based on the rigorous computational fluid dynamics (CFD) modeling of the fuel assembly geometry. The staff evaluated the fuel assembly flow resistance modeling approach described in Holtec Report HI-2053376, Rev. 7, and found that the analytical approach that represents the rod array as the fuel assembly configuration is consistent with CoC No. 1014, Amendment No. 5, previously approved by NRC and is acceptable.

PG&E then performed a steady state evaluation of the model with unblocked inlet vents. The final converged temperature and pressure fields were used as the initial conditions for the subsequent transient time steps in which the inlet vents were completely blocked (100% blockage) by setting their air velocity to zero. The steady state model was switched to the unsteady mode, and time stepping was initiated with small time steps at the beginning with slowly increasing time steps during the course of transient simulation.

The staff evaluated the revised computer model provided by PG&E and ensured that the He inside the MPC was modeled as a porous media and the heat source and its circulation was simulated as a laminar flow. The k-□ turbulence model was applied to the annulus with transitional flow, compressibility, and shear flow correction enabled. The time step size was increased from 1 second to 8 seconds, with a maximum iteration of 50 steps during the 33-hour transient duration for the first transient simulation. It was then increased from 0.5 second to 4 seconds, with a maximum iteration of 100 steps during the same transient duration for the second transient simulation that was adopted for the sensitivity analysis. Based on these observations the staff found that (1) the modeling features were consistent with the numerical methods described in HI-2053376, Rev. 7, Appendix D and CoC No. 1014, Amendment No. 5, (2) the second evaluation matched well with the first evaluation and indicated that the time step size and maximum iteration number used in the revised model were acceptable for the evaluation of vent blockage event, and (3) both fuel cladding temperature and MPC internal pressure fell below the allowable design-basic limits.

The staff used PG&E's model to perform a confirmatory base-case (steady-state) evaluation for the vent blockage accident. The staff found the PG&E model was acceptable. However, the staff identified that the uniform meshing in the annular gap (air side) between MPC outer shell

and concrete inner shell was relatively coarse, and that a finer uniform meshing or a non-uniform meshing with a very-fine mesh near the wall would accurately simulate the flow pattern in the near-wall region. A more accurate simulation using this approach could increase the fuel cladding temperature by approximately 50ºF. However, considering (1) the safety margins of approximately 200ºF in fuel cladding temperature, (2) the safety margin of approximately 120 psia in MPC internal pressure, and (3) the application of the key modeling approaches consistent with CoC No. 1014, Amendment No. 5, the staff finds that 50ºF is an acceptable uncertainty in PG&E's revised approach. Therefore the approach is sufficient to evaluate the blocked-vent accident condition for the specific modified Diablo Canyon HI-STORM 100 Cask System and heat load. The staff does not automatically approve this as a method of evaluation for future design or content changes that could significantly reduce these margins.

Sensitivity Analyses

PG&E performed the sensitivity analyses to ensure that both flow pattern and thermal phenomena were accurately characterized, and validated that the final solutions are independent of time-step size and iteration number used for evaluation. To do this, PG&E performed the transient simulations by reducing the time-step size by half and increasing the maximum number of iterations per time step to 100. PG&E analyzed the convergence within the maximum iterations throughout the transient period and predicted the same peak fuel cladding temperature and the same maximum MPC internal pressure as in the first transient confirming that the solutions were both converged in time for the 100% blocked-duct accident. The staff evaluated the results from two transient simulations reported by PG&E and found that they appear to match with each other, with no significant differences between the two transients. Based on this information, the staff finds that the solutions are independent of time step size and maximum number of iterations in this model configuration and are acceptable for evaluating the requested change of TS 3.1.4.

Vent Blockage Analytical Results

The design-basis accident analysis was performed by utilizing a thermal evaluation of the normal long term storage, evaluating the off-normal conditions, and then evaluating the accidental conditions. This was performed using the original licensing basis methodology supporting CoC No. 1014, Amendment No.1. The results provided by PG&E indicated all cask temperatures and MPC internal pressures fell below the allowable limits with acceptable safety margins (Tables 2 ~ 9 in HI-2053376, Rev. 7), and were in compliance with Part 72. The transient analysis during the 100% vent blockage event was generally based on the CoC No. 1014, Amendment No. 5, evaluation and indicated that the peak fuel cladding temperature remained well below the allowable temperature limit of 1058ºF with a safety margin of approximately 200ºF throughout the 33-hour duration of the event (Figures D.1 and D.2 of HI-2053376, Rev. 7). PG&E indicated that the fuel cladding would not be damaged during 33-hour duration of the vent blockage and determined that elimination of the coincident 100% fuel rod rupture was appropriate. PG&E also stated that the maximum MPC internal pressure of 91.6 psia remained below the accident pressure limit of 214.7 psia (Figures D.1 and D.2 of HI-2053376, Rev. 7), and therefore, the MPC confinement boundary would not be damaged during the 33-hour duration of the 100% vent blockage.

The staff applied the guidance in Interim Staff Guidance (ISG) -11, Rev. 3, for fuel cladding temperatures in dry storage casks to evaluate the integrity of the cladding material. Based on this criterion for off-normal and accident conditions, the maximum cladding temperature should not exceed 1058ºF. Therefore, the staff found the maximum cladding temperature of 854ºF (HI-2053376, Rev.7, Appendix D, Figures D.1 and D.2), throughout the 33-hour duration of the accident remains remained below the 1058ºF limit. Based on the PG&E analyses, there is no

reasonable mechanism for fuel cladding failure as a result of the 100% vent-blockage event. Therefore, the staff finds that the concurrent failure of fuel cladding as a result of vent-blockage is not a credible design basis event acceptable.

6.2.3 Conclusions

Based on the review of the statements and calculations provided in LAR 08-001, the staff finds that: 1) the proposed revision in TS 5.1.3 is adequately described and is consistent with the safety bases of SNM-2511, and 2) the methods used in the thermal evaluation for the proposed revision of TS 3.1.4 are sufficient and the corresponding thermal features (temperatures and MPC internal pressures) fall below the allowable design-basis limits with acceptable safety margins. Therefore, the staff finds that the proposed revisions in TS 3.1.4 and TS 5.1.3 satisfy the requirements of 10 CFR Part 72.

6.2.4 Conditions of the TS and License

Specific conditions are specified for approval of LAR 08-001.

1) TS 3.1.4 Spent Fuel Storage Cask (SFSC) Time Limitation in Cask Transfer Facility (CTF) is removed. This was based on a site-specific analysis of the thermal-hydraulic performance of the modified HI-STORM 100 Cask System that indicates there was no need for a required time limitation in the CTF. The removal of the time limitation in the CTF was based on the modified MPC-32 and transfer cask identified in the Diablo Canyon ISFSI FSAR, Revision 2, Table 4.2-1.
2) TS 5.1.3(b) was revised per the following to provide additional clarity:

   5.1.3(b) Verify that the water is maintained to provide adequate cooling in the annular gap between the loaded MPC and the transfer cask during MPC moisture removal operations under use of vacuum drying process for low burnup fuel (≤ 45,000 MWD/MTU). Verify that there is no water present in the annular gap between the loaded MPC and the transfer cask during MPC moisture removal operations under use of forced helium dehydration process.

The revision is an administrative change and is acceptable.

6.3 EVALUATION FINDINGS

F6.1 SSCs important to safety are described in sufficient detail in Sections of LAR 08-001 to enable an evaluation of their heat removal effectiveness, and SSCs important to safety remain within their operating temperature ranges in accordance with 10 CFR 72.122.

F6.2 The spent fuel cladding is protected against degradation that leads to gross ruptures by maintaining the cladding temperature for the previously approved contents below 1058ºF for normal, off-normal, and vent-blockage accident events while in the CTF. Protection of the cladding against degradation will allow ready retrieval of spent fuel assembly for further processing or disposal as required by 10 CFR 72.122.

7 SHIELDING EVALUATION

The proposed changes do not impact the original shielding evaluation. Therefore an evaluation was not required.

8 CRITICALITY EVALUATION

The following proposed revisions were evaluated for their impact on criticality safety:

- Addition of a note to TS 3.2.1, "Dissolved Boron Concentration," to allow for linear interpolation of required boron concentration between 2000 ppm and 2600 ppm for maximum fuel enrichment from 4.1 wt% to 5.0 wt% (Proposed revision 1.3).

- Revision of TS 3.2.1 to add a note to both surveillance requirements to limit the monitoring requirement to loading operations and unloading operations with water and at least one fuel assembly in the MPC (Proposed revision 1.4).

- Revision of TS 4.1.1a, TS 4.1.1b, and TS 4.1.1c to add Metamic as an allowable alternative to Boral as neutron absorber and specifications for the corresponding boron-10 content requirement for each specific MPC design (Proposed revision 1.5).

The staff evaluated the criticality safety analysis provided in LAR 08-001 and reviewed the FSARs supporting CoC No. 1014, Amendment Nos. 1, 3, and to ensure that all credible normal, off-normal, and accident conditions were identified and their potential consequences on criticality safety considered such that SNM-2511, as amended, continues to meet the regulatory requirements of 10 CFR 72.24(c) (3), 72.24(d), and 72.124.

8.1 Modification of TS 3.2.1, "Dissolved Boron Concentration"

The current TS 3.2.1 sets the soluble boron concentration limits for the MPC-32 canister at two discrete levels, 2000 ppm for fuel enrichments up to 4.1 wt% U-235 and 2600 ppm for fuel enrichments between 4.1 wt% and 5.0 wt% U-235. LAR 08-001 proposed to use borated water with boron concentration linearly interpolated between 2000ppm and 2600ppm for fuel enrichment between 4.1 wt% and 5.0 wt%. PG&E's justification was that the NRC approved this approach in CoC No. 1014, Amendment No. 3.

The staff reviewed the technical basis provided in LAR 08-001 as well as that in CoC No. 1014, Amendment No. 3. The staff also performed independent confirmatory analyses for the relationships between k_{eff} and fuel enrichment, and k_{eff} versus soluble boron concentration in the fuel enrichment and soluble boron concentration ranges. The results show that fuel enrichment and soluble boron concentration exhibit an approximately linear relationship. Based on its review and independent confirmatory analyses, the staff finds that using linear interpolation provides a reasonably accurate scheme for determining the required boron concentration in the enrichment and boron concentration ranges; for instance fuel enrichment between 4.1 wt% and 5.0 wt% and the corresponding soluble boron concentration of 2000 ppm to 2600 ppm boron. Therefore, the staff finds that this approach is acceptable.

8.2 Addition of note to TS 3.2.1 to limit monitoring requirements

PG&E proposed to revise the applicability of the TS to loading and unloading operations in order to provide consistency with the requirements of CoC No. 1014, Amendment No. 1. PG&E's proposed notes to TS 3.2.1 would eliminate the soluble boron concentration surveillance requirement for every 48 hours when the MPC is filled with borated water unless the MPC is submerged in borated water, or water is intentionally added or re-circulated. PG&E's justification was that the NRC approved this approach in CoC No. 1014, Amendment No. 1.

The staff evaluated the PG&E's justification and found the proposed amendment cannot provide

detection of unintended boron dilution in the MPC while it is loaded in all applicable cases at the Diablo Canyon ISFSI. The staff provided license condition 5.1.3 (m) to clarify the bounds of applicability.

5.1.3 (m) Verify that operational controls and surveillance criteria are adequate to maintain minimum soluble boron concentrations within the MPC while outside of the spent fuel pool. The controls shall consider potential water recirculation activities in the cask system and potential use of external water sources (if any) near the system during normal and off-normal operations.

The staff additionally revised the FREQUENCY from 8 to 4 hours prior to commencing LOADING OPERATIONS to provide consistency with CoC N0. 1014, Amendment No. 1. With these conditions, the staff finds that the revised boron concentration surveillance provides reasonable assurance for detecting dilution of the borated water in the MPC and maintaining criticality safety.

8.3 Revision of TS 4.1.1 and TS 4.1.2 to allow use of Metamic as alternative neutron absorbers

The current TS 4.1.1 and TS 4.1.2 only permit use of Boral as neutron absorber. LAR 08-001 proposed to use either Boral or Metamic materials as neutron absorbers. PG&E's justification for this revision was that the NRC previously approved the use of Metamic as neutron absorber in CoC No. 1014, Amendment No. 3.

The staff reviewed PG&E's justification and found the proposed revision to use Metamic as an alternative neutron absorber acceptable because PG&E demonstrated that Metamic provides equivalent neutron absorption capability as Boral as long as the equivalent amount of ^{10}B is loaded in the cask in a distribution similar to that of the Boral plates. The ^{10}B requirements defined in the revised TS 4.1.1 and TS 4.1.2 provide further assurance that adequate neutron absorption capability is provided by Metamic.

8.4 Criticality Evaluation Summary

In its evaluation the staff did not review or approve the methods used by PG&E in LAR 08-001or those in CoC No. 1014, Amendment No. 3. The staff found that the methods were consistent with those provided in the original application with the exception that the dimensional tolerances of the Metamic panels were not provided. The staff performed confirmatory analyses using the CSAS6/KENO.VI modules of SCALE developed by Oak Ridge National Laboratory. The code is a widely used in the industry for performing criticality analyses. The results of the staff's confirmatory calculations found PG&E's assessment of existence of a linear relationship between the soluble concentration and fuel enrichment for the same criticality state acceptable.

Based on PG&E's criticality evaluation for LAR 08-001, as confirmed by the staff, the staff has reasonable assurance that the Diablo Canyon ISFSI system will remain subcritical, with an adequate safety margin, under all credible normal, off-normal, and accident conditions.

8.5 Evaluation Findings

Based on its review of LAR 08-001, the staff finds that SNM-2511, as amended, continues to meet the regulatory requirements of 10 CFR 72.124, and the acceptance criteria specified, for both intact and damaged fuel. The evaluation of the criticality design provides reasonable assurance that the Diablo Canyon ISFSI will continue to allow safe storage of spent fuel. This

finding is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted engineering practices. In addition, the staff finds the following:

F8.1 SSCs important to safety with respect to criticality safety are described in sufficient detail in LAR 08-001 to enable an evaluation of their effectiveness

F8.2 The Diablo Canyon ISFSI system is designed to be subcritical under all credible conditions.

F8.3 The NRC staff finds that the criticality design features for SNM-2511 and associated TS, as amended, continues to be in compliance with 10 CFR Part 72, and that the applicable design and acceptance criteria have been satisfied.

9 CONFINEMENT EVALUATION

9.1 OBJECTIVE

The objective of the confinement evaluation is to confirm the confinement features proposed in LAR 08-001 continue to ensure radiological releases to the environment will be within acceptable limits, and that the spent fuel cladding will be sufficiently protected during storage operations against degradation.

The following proposed revision was evaluated for its impact on confinement.

TS 3.1.1, "Multi-Purpose Canister (MPC)" was proposed to be revised to clarify that the He leakage test would be implemented on the vent and drain port cover plate welds (Proposed revision 1.1). PG&E also proposed that the structural-lid-to-shell weld could be precluded from He leakage testing by following the recommended guidance in ISG-18, Rev. 1, as an acceptable method to meet the applicable regulatory requirements for confinement integrity.

The original confinement licensing basis for SNM-2511 was based on the design and confinement evaluation approved by the staff in CoC No. 1014, Amendment No. 1. As described in SER, Section 2, PG&E modified the cask confinement system. However, these modifications do not influence the leak testing requirements requested to be revised in LAR 08-001. With the exception of the accident pressure evaluation described in SER, Section 6, the staff did not evaluate or explicitly approve the modified design or confinement performance of the modified HI-STORM 100 Cask System under normal, off-normal, and accident conditions as part of the LAR 08-001 evaluation. The staff applied the acceptance criteria and review procedures in NUREG-1567 “Standard Review Plan for Spent Fuel Dry Storage Facilities” and applicable ISGs, to evaluate LAR 08-001 in accordance with the review objectives and for compliance with
10 CFR Part 72.

9.2 EVALUATION

The Holtec HI-STORM 100 MPC is the confinement system used for the Diablo Canyon ISFSI. It is a totally welded, cylindrical pressure vessel. All closure welds are examined using the liquid-penetrant method and He leak tested to ensure their integrity. MPC components that may come into contact with spent fuel pool water or the ambient environment, with the exception of neutron absorber and aluminum seals on vent and drain port caps, are made of stainless steel. The canister shell, base plate, lid, vent and drain port cover plates, and closure ring are the main

confinement boundary components. Following the welding of the cover lid, the HI-STORM 100 MPC-32 is backfilled with He and the confinement barrier is tested leaktight. Therefore radiological release to the environment is not credible and an inert environment with adequate cooling capabilities is provided to prevent cladding degradation

9.2.1 Modification of TS 3.1.1 Helium Leakage Test Evaluation

PG&E proposed revisions to TS 3.1.1 to provide consistency with the leak rate testing requirements CoC No. 1014, Amendment No. 3. PG&E clarified that the He leakage test would be implemented on the vent and drain port covers. They additionally proposed that the structural-lid-to-shell weld could be precluded from He leakage testing by following the recommended guidance in ISG-18, Rev. 1, as an acceptable method to meet the applicable regulatory requirements for confinement integrity. PG&E's proposed revising TS 3.1.1 to "MPC helium leak rate limit for vent and drain port cover plate welds not met" under Condition of Action C, and proposed revising Surveillance Requirements (SR) 3.1.1.3 to "Verify that the total helium leak rate through the MPC vent and drain port confinement welds meets the leaktight criteria of ANSI N14.5-1979." The staff reviewed Holtec CoC No. 1014, Amendment No. 3 and found the proposed changes of He leakage test in TS 3.1.1 are consistent with NRC-approved CoC 1014, Amendment No. 1, and are in compliance with 10 CFR 72.104, 72.106, 72.122(h) and 72.126(d) and consistent with the criteria in ISG-18, Rev.1.

In its letter dated September 1, 2009, PG&E proposed revising FSAR Table 3.4-6, "List of ASME Code Alternatives for HI-STORM 100 System" to "If PT alone is used, at a minimum, it will include the root and final weld layers and each approximately 3/8-inch of weld depth (minimum of 3 weld layers)" for the MPC Lid-to-Shell Weld and the MPC Enclosure Vessel and Lid**.** Using the guidance of ISG-18, Rev. 1, the staff revised the statement to "For the MPC lid-to-shell weld and the MPC enclosure vessel and lid, the weld must be at minimum of three weld layers. If PT alone is used, it will be tested at least three different weld layers, including the root and final weld layers and each approximately 3/8-inch of weld depth." The staff found this language to be clearer and more consistent with the intent and criteria of ISG-18, Rev. 1. This has been added as an administrative control as T.S. 5.1.3 (k) to ensure consistency with the criteria for the structural-lid-to-shell welds.

9.2.2 Conclusions

The staff finds that the proposed revision to TS 3.1.1, with additional modification, is acceptable.

9.2.3 Limitations and Conditions in Technical Specification

The following license and TS revisions are included as conditions of LAR 08-001 approval:

1) Revise TS 3.1.1 (Action C) to "MPC helium leak rate limit for vent and drain port cover plate welds not met" to confirm that the helium leakage testing of MPC vent and drain port cover plate welds will be implemented to satisfy the leaktight criteria to meet safety regulations.

2) Revise SR 3.1.1.3 to "Verify that the total helium leak rate through the MPC vent and drain port confinement welds meets the leaktight criteria of ANSI N14.5-1997."

3) Add new administrative control T.S. 5.1.3 (k) as "For the MPC lid-to-shell weld and the MPC enclosure vessel and lid, the weld must be at minimum of three weld layers. If PT

alone is used, it will be tested at least three different weld layers, including the root and final weld layers and each approximately 3/8-inch of weld depth."

9.3 EVALUATION FINDINGS

F9.1 The design and proposed operations of the Diablo Canyon ISFSI continue to provide adequate measures for protecting the spent fuel cladding against degradation that might otherwise lead to gross ruptures of the material to be stored, in compliance with 10 CFR 72.122(h)(1).

F9.2 The Diablo Canyon ISFSI confinement system will continue to be appropriately leak tested to demonstrate that it will reasonably maintain confinement of radioactive material under normal, off-normal, and credible accident conditions.

F9.3 The staff finds that the design of the confinement system of the cask is in compliance with 10 CFR Part 72, and that the applicable design and acceptance criteria remain satisfied as a result of LAR 08-001. This finding is reached on the basis of a review that considered the regulation itself, appropriate regulatory guidance documents, applicable codes and standards, the information provided by PG&E, and accepted engineering practices.

10 CONDUCT OF OPERATIONS EVALUATION

The proposed changes do not impact the original conduct of operations evaluation. Therefore an evaluation was not required.

11 RADIATION PROTECTION EVALUATION

The proposed changes do not impact the original radiation protection evaluation. Therefore an evaluation was not required.

12 QUALITY ASSURANCE EVALUATION

The proposed changes do not impact the original quality assurance evaluation. Therefore an evaluation was not required.

13 DECOMMISSIONING EVALUATION

The proposed changes do not impact the original decommissioning evaluation. Therefore an evaluation was not required.

14 WASTE CONFINEMENT AND MANAGEMENT EVALUATION

The proposed changes do not impact the original shielding evaluation. Therefore an evaluation was not required.

15 ACCIDENT EVALUATION

15.1 OBJECTIVE

The objective of the accident evaluation is to confirm that the analysis of hazards for both off-normal and credible design basis events for SSCs important to safety that may be affected by the specified TS changes proposed in LAR 08-001 is acceptable. The staff applied the acceptance criteria and review procedures in NUREG-1567 “Standard Review Plan for Spent Fuel Dry Storage Facilities” and applicable ISGs to evaluate LAR 08-001 in accordance with the review objectives and for compliance with 10 CFR Part 72.

Because the thermal performance of the system is influenced by the revised design characteristics of the modified Diablo Canyon HI-STORM 100 Cask System, the staff requested PG&E to provide thermal and confinement analyses affected by the TS revisions, based on the modified design. Given potential uncertainties in the analytical approach utilized in CoC No. 1014, Amendment No.1, and the pressure safety margins associated with the modified Diablo Canyon HI-STORM 100 Cask System, the staff requested PG&E perform the blocked-vent thermal accident analyses using a more accurate analytical approach consistent with the previously approved CoC No.1014, Amendment No. 5. The staff did not review or explicitly approve the modified design or performance of the modified Diablo Canyon HI-STORM 100 system, under off-normal or accident conditions, as part of the LAR 08-001 evaluation.

15.2 EVALUATION

15.2.1 Off-Normal Events

15.2.1.1 Partial Vent Blockage

As described in SER, Section 6, PG&E analyzed the impact of restricted vent blockage for an off-normal scenario in which the modified MPC-32 and transfer cask could not be readily removed from the CTF. The results of the analyses indicated that cladding temperatures and internal canister pressures remain below allowable limits for off-normal events at steady state. Therefore, the staff finds the TS revision eliminating time requirements during CTF operations is acceptable.

15.2.2 Accidents

15.2.2.1 Adiabatic Heat-Up (Vent Blockage)

As described in SER, Section 6, PG&E analyzed the impact of full vent blockage. PG&E revised the vent blockage methodology to be consistent with the analytical approach used in CoC No. 1014, Amendment No. 5. The results of the analyses indicated the cladding temperatures and internal canister pressures remain below the allowable limits for accident conditions and 100% coincident cladding failure is not credible. Therefore, the staff finds the TS revision eliminating time requirements during CTF operations acceptable.

15.3 EVALUATION FINDINGS

F15.1 PG&E provided acceptable analyses of the design and performance of SSCs important to safety under off-normal and accident scenarios. Applicable off-normal accidents, analyzed in the application, included partial vent blockage and operational events

involving potential failure of the CTF. Applicable accident events, analyzed in the application, included adiabatic heat-up (blocked vents) of the modified cask. The results provided by PG&E indicated all cask temperatures and MPC internal pressures are below the allowable limits with acceptable safety margins in compliance with 10 CFR Part 72.

F15.2 The analyses of off-normal and accident events and conditions and reasonable combinations of these and normal conditions show that SNM-2511, and associated TS, as amended, continues to be in compliance with 10 CFR Part 72, and that the applicable design and acceptance criteria have been satisfied.

16 TECHNICAL SPECIFICATIONS

TS changes are documented and evaluated in previous sections to this SER.

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February 10, 2010