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September 9, 2011

PG&E Letter HIL-11-006
ATTN: Document Control Desk
Director, Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

10 CFR 72.56

Materials License No. SNM-2514, Docket No. 72-27
Humboldt Bay Independent Spent Fuel Storage Installation
<u>Response to NRC Request for Additional Information for License Amendment Request 10-01, Revision to License Condition 7.B</u>

Dear Commissioners and Staff:

On September 8, 2010, Pacific Gas and Electric Company (PG&E) submitted License Amendment Request (LAR) 10-01, to amend Materials License No. SNM-2514, Docket No. 72-27, for the Humboldt Bay (HB) Independent Spent Fuel Storage Installation (ISFSI). PG&E proposed to change License Condition 7.B by adding process wastes to the Chemical and/or Physical Form description of Greater Than Class C (GTCC) waste authorized to be received, possessed, transferred, and stored at the HB ISFSI.

On January 28, 2011, PG&E submitted supplemental information for LAR 10-01 in response to a November 9, 2010, NRC request for supplemental information. Subsequently, on June 10, 2011, the NRC submitted a request for additional information (RAI) that PG&E should provide by September 9, 2011.

PG&E has been working with the GTCC waste cask vendor, Holtec, Inc. (Holtec) to respond to the RAI. Holtec requested clarification of the RAI, and on August 11, 2011, personnel from the NRC, PG&E and Holtec held a conference call. As a result of the clarification, PG&E is providing RAI responses in the enclosure to this letter.

Because of the technical content of PG&E's RAI responses to NRC questions regarding hydrogen generation and the potential for water content in the low density grout to be used in the Greather than Class C Waste Container (GWC), PG&E is making note of the following statement previously made in Section 4.0, "Technical Analysis," of LAR 10-01: "The material will be organic free, such that there is no off gassing during storage, the material will be dry to preclude any corrosion during storage, and will be encapsulated in discrete containers for ease of loading in the cask along with the activated metal components." The statement may imply that organics are the only potential source of gas generation during storage and therefore, because the cask contents will be free of organics, there will be no gas generation. In fact, PG&E's response to RAI-1 assumes a conservative value for water content in the grout. The results of the related calculation show that hydrogen generation from radiolysis will occur, but the total amount will be minimal and poses no challenge to GWC integrity. Additionally, most or all of the water in the grout is expected to be chemically bound in the grout and not in free (liquid) form; therefore, it is still expected that there will be no corrosion during storage.

If you have any questions or require additional information, please contact Mr. David Sokolsky at (707) 444-0801.

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

Executed on September 9, 2011.

Sincerely,

John T. Conway

John T. Conway
Senior Vice President – Energy Supply & Chief Nuclear Officer

Enclosure
cc w/encl: Gary Butner, California Department of Public Health
Elmo E. Collins, NRC Region IV
John B. Hickman, NRC
William C. Allen, NRC
Humboldt Distribution

PG&E RESPONSES TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)

RELATED TO LICENSE AMENDMENT REQUEST 10-01

RAI-1

Provide an analysis of the effect of radiolysis of water in the grout on the Maximum Normal Operating Pressure of the GTCC Waste Container (GWC) and the potential generation of flammable hydrogen gas in the GWC over the life of the ISFSI. Provide any assumptions and/or documents supporting the analysis.

A source[1] consulted by the staff indicates that there is a potential for gas generation, including flammable hydrogen, due to the radiolysis of water in grout used to encapsulate the GTCC waste. This could potentially affect the pressure of the GWC and needs to be evaluated.

This information is requested in accordance with 10 CFR 72.128(a)(3).

1. *C.D. Jonah, S. Kapoor, D. Meisel and M.S. Matheson, "Radiolytic and Thermal Generation of Gases from Hanford Grout Samples," Argonne National Laboratory, ANL-93/42, October 1993.*

PG&E RESPONSE

Hydrogen generation from radiolysis of the grout will be minimal and pose no challenge to GWC integrity. Most or all of the water in the grout is expected to be chemically bound in the grout and not in free (liquid) form. Further, even if a small amount of hydrogen were to be generated inside the GWC over its lifetime, there will be no ignition source inside the GWC; therefore, no ignition of any hydrogen buildup could occur.

It should be noted that the paper referenced in the request for additional information (RAI) (Reference [1]) may not necessarily be applicable to the condition in the HB GWC with Greater Than Class C (GTCC) waste. In Reference [1] the grout is mixed with simulated liquid nuclear waste, while the HB GWC contains only activated solid metal waste (predominantly Cobalt-60) in the grout. The liquid waste in [1] contains nitrates and nitrites, which may result in an increase in gas generation compared to grout prepared with plain water. [1] also references other studies (as discussed in the Summary section of [1]) for grout with liquid waste, which found hydrogen generation rates almost a factor of 10 lower than those reported in [1]. This indicates the large influence of liquid waste on the hydrogen production. Nevertheless, as a sensitivity study, the pressure buildup in the GWC is estimated based on the information in [1], to demonstrate that even if there were to be gas generation, the GWC pressure limits would not be challenged.

For this estimation, the following approaches and assumptions were used:

- A water weight content of 20 percent is stated in [1]. While the grout for the GWC may be mixed with higher water content, the overall weight fraction in the mixture of the steel and grout in the GWC would be similar to the value of 20 percent due to the presence of the steel. Therefore, the applicable G-values (see calculation inputs on page 3 of 6 of this enclosure) from [1] are directly applicable to the GWC without any further conversion.
- Regarding the different gases discussed in [1]:
  - N_2 and N_2O are not considered applicable here, since they are considered in [1] to be the result of the significant nitrate and nitrite concentrations in the liquid waste, which are not present in the GTCC waste in the GWC.
  - O_2 is also discussed in [1] as being the result of the nitrates and nitrites; however, since O_2 is also generated in the radiolysis of water, the G-value of 0.026 molecules/100eV is also used here.
  - For H_2, a G-value of 0.049 molecules/100eV is also used here.
  - CO and CH_4 are neglected since their generation is small compared to H_2 and O_2.
- As a bounding assumption, a gas temperature of 400 °K is used, which bounds both normal and accident conditions. Note that the cobalt is the only relevant source of heat in the GWC. The maximum amount of gas corresponds to the time when all Cobalt-60 has decayed; heat generation is essentially zero at that time.

With these assumptions, the total amount of hydrogen and oxygen generated over the entire life of the GWC is approximately 11 mol. This would result in a pressure increase in the GWC of about 22 psi. The GWC will be filled with grout leaving a void space at atmospheric pressure. The GWC pressure limits are 100 psig for normal operations and 200 psig for accident conditions. Therefore, after accounting for the potential gas generation, substantial margin to both the normal and accident condition pressure limits would exist.

GWC GAS GENERATION CALCULATION

References

[1] Radiolytic and Thermal Generation of Gases from Hanford Grout Samples, ANL-93/42, Argonne National Laboratory, October 1993

[2] GE Chart of Nuclides

[3] Contents of the GTCC cask, Letter from PG&E to Holtec dated 7/19/2011

[4] Holtec Drawing 6114 Rev. 3

Unit Definitions/Conversions

$eV := 1.6 \cdot 10^{-19} J$

$MeV := 10^{6} eV$

$Ci := 3.7 \cdot 10^{10} \cdot \frac{1}{s}$

$molecules := 1$

Inputs

$t12 := 5.271 yr$	Half - Life of Co-60 [2]
$ge_{co60} := (1.3325 + 1.1732) MeV$	Total Gamma Energy of Co-60 decay [2]
$G_{H2} := 0.049 \frac{molecules}{100 eV}$	H2 generation [1]
$G_{O2} := 0.026 \frac{molecules}{100 eV}$	O2 generation [1]
$act_{co60} := (282 + 70.6 + 28) Ci$	Total Cobalt Activity [3]
$Avo := 6.022 \cdot 10^{23} \frac{molecules}{mole}$	Avogadro Constant [2]
$Rm := 8.3145 \frac{J}{mol \cdot K}$	Gas Constant [2]
$temp := 400 K$	Temperature (assumed)

$Vf_{id} := \left(68 + \frac{3}{8} - 2\cdot\frac{1}{2}\right)in$ ID of free volume in GWC

$Vf_{id} = 67.375\,in$

$Vf_h := \left[114 - \left(9 + \frac{1}{8}\right) - \left(4 + \frac{3}{4}\right) - 94\right]in$ Height of free volume in GWC

$Vf_h = 6.125\,in$

$Vf_h := 4in$ Conservative height of free Volume used to allow flexibility in the filling of the GWC with grout.

Results

1. Energy Absorbed and Average Dose in Grout

$E_t := act_{co60}\cdot\frac{t12}{\ln(2)}\cdot ge_{co60}$ $E_t = 1.355\times 10^9\,J$ Total Energy

2. Hydrogen and Oxygen Generated

$Gen_{H2} := E_t\cdot\frac{G_{H2}}{Avo}$ $Gen_{H2} = 6.89mol$

$Gen_{O2} := E_t\cdot\frac{G_{O2}}{Avo}$ $Gen_{O2} = 3.656mol$

3. Pressure in free volume

$Vf := \frac{\pi}{4}\cdot Vf_{id}^{\,2}\cdot Vf_h$ $Vf = 8.253\,ft^3$ Free Volume

$pressure := \frac{Rm\left(Gen_{H2} + Gen_{O2}\right)\cdot temp}{Vf}$ $pressure = 1.481\,atm$ Pressure

$pressure = 21.768psi$

RAI-2

Provide a brief description of the process of sealing of the GTCC cask, including the welding and subsequent leak testing of the GWC. Include details on how helium leak testing of the entire confinement boundary is completed in accordance with ANSI N14.5-1997.

From the description of the closure of the GTCC cask, after the placement of the process waste canister and subsequent welding of the GWC, it is not clear whether the closure, sealing, and leak testing procedures for the HI-STAR cask system are followed for the GTCC cask.

This information is requested in accordance with 10 CFR 72.128(a)(3).

PG&E RESPONSE

Overall GWC construction meets ISG-18 as described in Final Safety Analysis Report (FSAR) Table 4.2.3. The welding of the GWC closure lid is identical to that performed on the spent fuel multi-purpose canisters (MPCs) described in FSAR section 4.2.3.2.1. The fabricated GWC is subjected to a helium leak test in the shop prior to its delivery to HB. For GWC closure, water is first blown down. The void space is then filled with low density grout to absorb any remaining free liquid, provide additional shielding, and stabilize the GTCC waste material within the GWC. Only the port cover plates are subject to a post-weld helium leak test under ISG-18.

The GTCC waste overpack is not designed as a sealed pressure vessel, because it is utilized only for shielding and structural protection during storage and transportation. As such, for final closure the annulus water is drained and the lid is installed and bolted. No drying or backfilling is required.

The information contained in this response will be incorporated into the HB Independent Spent Fuel Storage Installation (ISFSI) FSAR.

RAI-3

Specify the industrial code which will be used to establish the mixing, chemistry, placement, properties and acceptance tests of the grout.

This information is requested in accordance with 10 CFR 72.122(d).

PG&E RESPONSE

There are two different grout materials used in the GWC for HB GWC. The first grout material is a high-density material (i.e., concrete) in an annular region just inboard of the GWC shell, which is prepared and placed inside the GWC prior to GTCC waste loading operations. The second grout material is a low-density, flowable material interspersed with the GTCC waste activated metals, which is prepared and placed during GTCC waste loading operations at HB.

The high-density grout is prepared and placed using the same procedures used to place shielding concrete in the lids and pedestals of the Holtec International Storage and Transfer Operation Reinforced Module (HI-STORM) 100 cask system overpacks (NRC Docket 72-1014). As stated in Appendix 1.D of the HI-STORM 100 FSAR:

> "Table 1.D.1 provides the material limitations and requirements applicable to the … concrete. These requirements, drawn from ACI 349-85 and supplemented by the provisions of NUREG 1536 (page 3-21), are intended to ensure that the "*critical characteristics*" of the concrete … comply with the requirements of this Appendix and standard good practice."

and

> "In accordance with the requirement in Section 3.3 of Appendix B of the HI-STORM 100 CoC, Section 1.D.4, Table 1.D.1 and Table 1.D.2 were developed using the guidance of ACI 349-85, to the extent it needs to be applied to the unique application of placing unreinforced concrete … Other concrete standards were used, as appropriate, to provide the controls necessary to assure that the *critical characteristics* of the … concrete will be achieved and that the concrete will perform its design function."

The controls for placement of concrete in the HI-STORM 100 cask system overpacks have been used for scores of dry cask systems and provide tested and reliable guidance for placement of high-quality shielding concrete.

The mix design for the low-density grout is still being developed and therefore the exact code that will be used to control the preparation and placement of this material has not yet been determined. It is intended, however, that applicable portions of ACI 318 and/or ACI 349 will be used to control the preparation and placement of this material. Because the only critical characteristics of the low-density grout are density and chemical composition and because the grout will not contain any coarse aggregate, many provisions of the ACI Codes will not apply. For example, ACI Code requirements on sieve testing of coarse aggregate, allowable slump, and drop height during placement will not be imposed on the low-density grout. Examples of ACI Code requirements that will be imposed include wet density measurement and limitations on the amount of water-soluble chloride ion.