April Rice
Manager
Nuclear Licensing

November 17 2016
NND-16-0414
10 CFR 50.90
10 CFR 52.63

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Virgil C. Summer Nuclear Station (VCSNS) Units 2 and 3
Combined License Nos. NPF-93 and NPF-94
Docket Nos. 52-027 & 52-028

Subject: LAR 13-09 R1 S2 License Amendment and Exemption Request: Annex and Radwaste Building Changes

1. South Carolina Electric & Gas Company (SCE&G) Request for License Amendment and Exemption: Annex and Radwaste Building Changes February 27, 2014 (NND-14-0048) (ML14065A022).

2. Letter from Ravindra G. Joshi (NRC) to Ronald Jones (SCE&G), Virgil C. Summer Nuclear Station Units 2 and 3: Request for Additional Information Letter No. 01 Related to Exemption and License Amendment Request (LAR) 13-09, for the Virgil C. Summer Nuclear Station Units 2 and 3: Annex and Radwaste Building Changes (ML14125A297)

3. South Carolina Electric & Gas Company (SCE&G) Request for License Amendment and Exemption S2: Annex and Radwaste Building Changes July 09, 2014 (NND-14-0383) (ML14192A036)

4. South Carolina Electric & Gas Company (SCE&G) Request for License Amendment and Exemption LAR 13-09 S2: Annex and Radwaste Building Changes September 25, 2014 (NND-14-0572) (ML14268A544)

5. South Carolina Electric & Gas Company (SCE&G) Request for License Amendment and Exemption LAR 13-09 S3: Annex and Radwaste Building Changes August 20, 2015 (NND-15-0490) (ML15236A100)

6. South Carolina Electric & Gas Company (SCE&G) Request for License Amendment and Exemption LAR 13-09 R1: Annex and Radwaste Building Changes December 17, 2015 (NND-15-0664) (ML15351A428)

7. South Carolina Electric & Gas Company (SCE&G) Request for License Amendment and Exemption LAR 13-09 R1 S1: Annex and Radwaste Building Changes June 1, 2016 (NND-16-0129) (ML16154A048)

8. Summer Annex and Radwaste Building Changes LAR 13-09 RAI LTR 02 July 25, 2016 (ML16207A387)

In accordance with the provisions of 10 CFR 50.90, South Carolina Electric & Gas Company (SCE&G) requests an amendment to the Virgil C. Summer Nuclear Station (VCSNS) Units 2 and 3 combined licenses (COLs) numbers NPF-93 and NPF-94, respectively. The proposed amendment would depart from VCSNS Units 2 and 3 plant-specific Design Control Document (DCD) Tier 1 and Tier 2 material contained within the Updated Final Safety Analysis Report (UFSAR), as well as COL Appendix C material, to modify the annex and radwaste buildings.

Subsequent to the Public Meeting held on June 30th 2016 to discuss reference 7 above, NRC issued follow-up RAI questions on July 25, 2016 (reference 8). The draft questions were discussed during the June 30th and October 20th Public Meetings with the NRC. As a result, SCE&G is providing this letter, which includes a response to the RAI questions. This supplement also includes editorial updates to the LAR and UFSAR text consistent with the RAI response.

Enclosure 20 of this LAR responds to the new NRC RAI questions. It also provides select updates with respect to the description and technical evaluation for the proposed changes in the License Amendment Request (LAR) and the proposed markups depicting the requested changes to publicly available information. Enclosure 21 provides Editorial changes. **Enclosure 15 of reference 6 contains the SUNSI information relevant to this LAR. Given that the information has not been changed, it was not duplicated in this supplement.**

The supplemental information provided in this letter does not impact the scope of the requested amendment, nor the conclusions of the regulatory evaluation. This includes the significant hazards consideration determination and the environmental considerations, which is not changed or affected by this supplement.

In order to support the VCSNS Unit 2 construction schedule, SCE&G requests NRC staff review and approval of the license amendment by January 3, 2017. Approval by this date will allow sufficient time to implement the licensing basis changes prior to affected construction activities. SCE&G expects to implement the proposed amendment within 30 days of approval. Southern Nuclear Operating Company (SNC) has stated that the current requested approval date for Vogtle Electric Generating Plant (VEGP) Unit 3 is December 31, 2016.

This letter contains no regulatory commitments.

In accordance with 10 CFR 50.91, SCE&G is notifying the State of South Carolina of this LAR by transmitting a copy of this letter and publicly-available enclosures to the designated State Official.

Should you have any questions, please contact Mr. Nicholas Kellenberger by telephone at (803) 941-9834, or by email at NICHOLAS.R.KELLENBERGER@scana.com.

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

Executed on this 17th day of November, 2016.

Sincerely,

April Rice
Manager
Nuclear Licensing

MMD/ARR/mmd

Enclosures 1-4:	Provided via reference 1 (revised by Enclosures 12-15)
Enclosures 5-8:	Provided via reference 3 (supplemented by Enclosure 16)
Enclosure 9:	Provided via reference 4 (supplemented by Enclosure 16)
Enclosure 10:	Provided via reference 5 (supplemented by Enclosure 11 & Enclosure 16)
Enclosure 11:	Provided via reference 6 (supplemented by Enclosure 16)
Enclosure 12-14:	Provided via reference 6 (supplemented by Enclosure 17-19)
Enclosure 15:	Provided via reference 6 **(SUNSI information unchanged)**
Enclosure 16:	Provided via reference 7 (supplemented by Enclosure 20)
Enclosure 17:	Provided via reference 7 (supplemented by Enclosure 20 & 21)
Enclosure 18:	Provided via reference 7 (unchanged)
Enclosure 19:	Provided via reference 7 (supplemented by Enclosure 20 & 21)
Enclosure 20:	Virgil C. Summer Nuclear Station Units 2 and 3 – SCE&G Response to NRC RAI Letter 2 (LAR-13-09 R1 S2)
Enclosure 21:	Virgil C. Summer Nuclear Station Units 2 and 3 – Editorial updates (LAR 13-09 R1 S2)

Copy (with enclosures):

Billy Gleaves
Paul Kallan
Chandu Patel
Ruth Reyes
DCRM-EDMS@SCANA.COM
Susan E. Jenkins
Tom Fredette
Tomy Nazario
Jennifer Dixon-Herrity
Sam Lee
Lisa Spears
Catherine Haney
Jim Reece
Stephen A. Byrne
Jeffrey B. Archie
Ronald A. Jones
Alvis J. Bynum
Kathryn M. Sutton
April Rice
Nicholas Kellenberger
Matt Kunkle
Mory Diané
Bryan Barwick
Dean Kersey
Matthew Presson
Cynthia Lanier
Lisa Spears
Frederick Willis
Neil Haggerty
Paige Ridgway
Carl Churchman
Ken Langdon
Pat Young
Zach Harper
Brian McIntyre
Brian Bedford
Joseph Cole
Chuck Baucom
Lisa Alberghini
Curt Castell
Jeff Hawkins
William M. Cherry
Rhonda O'Banion
VCSummerMail@westinghouse.com
VCSummer2&3project@westinghouse.com
VCSNNDCorrespondence@scana.com

South Carolina Electric and Gas Company

Virgil C. Summer Nuclear Station (VCSNS) Units 2 and 3

NND-16-0414

Enclosure 20

SCE&G Response to NRC RAI Letter 2

(LAR 13-09 R1 S2)

(This Enclosure consists of 15 pages, including this cover page.)

The purpose of this supplement is to address NRC RAI Letter 2 questions (reference 8). The RAI numbers are shown with the word “New” to distinguish them from previous RAI responses provided via reference 7 enclosure 16.

New RAI Question 9:

Section 20.1101 (b) of 10 CFR Part 20 states that the licensee shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses that are as low as is reasonably achievable (ALARA).

As a follow-up to a public meeting with the licensee held on February 3, 2016, the staff submitted three RAI Questions (Questions 9 through 11) to the licensee relating to shielding of the three proposed bunkers in the Waste Accumulation Room.

The licensee provided its response to staff RAI Questions 9 through 11 in Supplement 1 to Revision 1 to LAR 13-09 (June 1, 2016). In this response, the licensee stated that the back and side concrete shield walls surrounding the three bunkers in the Waste Accumulation Room “provide adequate shielding to maintain the radiation levels for the worker occupied areas in the radwaste building, and in the adjacent plant yard areas, as Zone I to Zone IV as defined in the proposed revision to UFSAR Figure 12.3-1 (Sheet 14), without the additional vertical shielding from the removable steel shield bunker roof plates and horizontal shielding from the removable steel shield bunker door plates.”

The licensee’s response goes on to state that

“Therefore, for normally occupied areas, the removable steel shield bunker roof plates and removable steel shield bunker door plates are provided for ALARA considerations only and for maximum operational flexibility.”

The licensee also states that, if access to the normally unoccupied radwaste building roof is required during storage of moderate or high activity waste in the bunkers, the use of a single 6” thick removable steel shield bunker roof plate above each bunker is adequate to maintain Zone II to Zone III radiation levels or less on the radwaste building roof.

Although the licensee’s response to each of RAI Questions 9 through 11 states that the removable steel shield bunker door plates in front of each bunker are not required to maintain the specified radiation zones in worker occupied areas of the radwaste building when moderate and high activity wastes are stored in the bunkers, this description of the function of the removable steel shield bunker door plates is not sufficiently addressed in Supplement 1 to Revision 1 to LAR 13-09 and is not addressed in the UFSAR. In order to address this issue, the staff requests that the licensee amend LAR 13-09 and the UFSAR to describe the functions of the removable steel shield bunker door plates and state that these removable shield plates are not relied upon to maintain the specified radiation zones in the adjacent worker occupied areas of the radwaste building when moderate and high activity wastes are stored in the bunkers.

SCE&G Response to New RAI Question 9:

As discussed and agreed to with the NRC during the public meeting held on 6/30/2016, the LAR (Sections 2.2 and 3.2) is updated with the following text:

> "The removable steel shield bunker door plates are not required to be installed to maintain radiation levels in the worker occupied areas in the radwaste building and in the adjacent plant yard areas as Zone I to Zone IV as defined in the proposed revision to UFSAR Figure 12.3-1(Sheet 14)."

This text is added in the brackets below from LAR13-09 R1 S1 (reference 7):

Enclosure 17 Section 2.2, page 4 of 23

> "...are proposed to be added for maintaining radiation levels ALARA and for maximum operational flexibility. [ ] The bunkers are structurally..."

Enclosure 17 Section 2.2, page 6 of 23

> "4) add a description of the design functions for the removable steel shield bunker door plates that may be installed for ALARA considerations. [ ]"

Enclosure 17 Section 3.2, page 9 of 23

> "...removable steel shield bunker door plates for as low as is reasonably achievable ALARA considerations~~;~~. [ ]"

Additionally UFSAR Subsection 12.3.2.2.5 is updated with the following text:

> "The removable steel shield bunker door plates are not required to be installed to maintain radiation levels in the worker occupied areas in the radwaste building and in the adjacent plant yard areas as Zone I to Zone IV as defined in UFSAR Figure 12.3-1(Sheet 14)."

This text is added in the brackets below from LAR13-09 R1 S1 (reference 7):

Enclosure 19 - UFSAR Subsection 12.3.2.2.5, page 14 of 14

> "…Zone II to Zone III on the normally unoccupied and access controlled radwaste building roof, and removable steel shield bunker door plates, that may be installed for ALARA considerations. [ ]"

New RAI Question 10:

Section 20.1301(e) of 10 CFR Part 20 states that, in addition to complying with the requirements of this part, each licensee shall comply with the radiation standards in 40 CFR Part 190. 40 CFR Part 190 states that the annual dose equivalent to a member of the public as the result of exposures to planned discharges of radioactive materials (radon and its daughters excepted) to the general environment from uranium fuel cycle operations and to radiation from these operations does not exceed 25 millirems (mrem) to the whole body.

The potential exposure pathways that should be considered when determining the maximally exposed individual dose for comparison with the 40 CFR Part 190 dose limits are the doses from liquid effluents, the doses from gaseous effluents, and the direct doses from radionuclides in plant equipment and systems and doses from sources stored on site (such as the direct doses from spent fuel stored in the ISFSI and irradiated components such as steam generators and reactor vessel heads that are stored onsite).

V. C. Summer UFSAR Table 11.3-206, "Comparison of Maximally Exposed Individual Doses with 40 CFR Part 190 Criteria," shows that the estimated total body dose from liquid and gaseous effluents from both of the V. C. Summer units is estimated to be 2.2 mrem/yr. Supplement 1 to LAR 13-09 (dated July 9, 2014) stated that the radiation levels on the radwaste building roof do not exceed radiation Zone II (less than or equal to 2.5 mrem/hr). The most recent version of this LAR, Supplement 1 to Revision 1 to LAR 13-09 (dated June 1, 2016), states that the radiation levels on the radwaste building roof could conceivably be as high as Zone IV (less than or equal to 100 mrem/hr) during storage of moderate and high activity waste in the bunkers.

On the basis of this apparent large increase in the estimated dose rate on the radwaste building roof, describe and show how this increase in the direct dose from the radwaste building roof effects your compliance with Section 20.1301(e) of 10 CFR Part 20.

SCE&G Response to New RAI Question 10:

Shielding calculations have examined dose rates on the radwaste building roof with several configurations of waste storage in the building as discussed below. These configurations were considered for building and shielding design only, and do not reflect additional administrative controls described in proposed UFSAR section 11.2.1.2.5.2 that may be necessary to ensure A1 and A2 limits are met. Therefore, these configurations are considered appropriate for shielding design activities.

The analysis of the design basis shielding configuration, with the WLS monitor tanks containing liquid at the design basis source term levels, dry active waste producing zone IV dose rates stored in the waste accumulation room, and waste capable of producing zone IV dose rates stored in the bunkers below a hypothetical 4.5" steel shield, shows dose rates on the roof of less than 8 mrem/hr, corresponding to zone III conditions.

Analyses of a more typical configuration, considering significantly fewer fuel defects, source terms that are more aligned with the expected source terms, and waste within the building producing lower surface dose rates, shows zone II dose rates on the roof.

A documented sensitivity study also indicates that if more typical WLS source terms are considered and waste within the Waste Accumulation Room were limited to 2.5 mrem/hr for a bulk of the room and 15 mrem/hr within the bunkers, then roof dose rates could be maintained below 1 mrem/hr. This configuration would keep dose rates on the roof at or near Zone I levels. However, it is conceivable that, for short term operations, if the bunker roof shielding were removed, and waste producing design basis dose rates were being moved within the building, that additional increases in the roof dose rate could occur. The dose rate on the roof during these transient circumstances would not exceed the dose rate within the building itself. Such dose rate increases would be temporary, however, and dose rates from the steady state storage configuration within the building would be maintained ALARA.

Based upon the results of the shielding analyses, described above, the shine pathway for radiation to pass to a member of the general public through the radwaste building roof is considered insignificant with respect to requirements in Section 20.1301(e) of 10 CFR Part 20.

New RAI Question 11:

10 CFR Part 50, Appendix A, GDC 61 requires, in part, that systems that may contain radioactivity be designed to assure adequate safety under normal and postulated accident conditions and shall be designed with appropriate containment, confinement, and filter systems.

10 CFR Part 50, Appendix A, GDC 3 requires that SSCs important to safety shall be designed and located to minimize the probability and effects of fires and explosions.

RG 1.189 indicates that the design should minimize fires and explosions, including those that could be associated with the release of radioactive material and exposure to workers. RG 1.189 also indicates that the fire hazard analysis should include explosion-prevention measures in areas subject to potentially explosive environments from flammable gases or other potentially energetic sources, including ion exchange columns.

In addition, SRP 11.4A, SECY-94-198, Generic Letter 81-38, Information Notice 90-50, and NUREG/CR-4601 also discuss preventing flammable/explosive conditions from spent resin.

1. LAR 13-09 includes the addition of three bunkers to the radwaste building. Staff's initial RAI, Question 6, requested that the licensee evaluate the LAR against the criteria in NUREG-0800, Section 11.4A. Section 11.4A includes discussion of gas generation and the potential for flammable/explosive conditions from radioactive waste. The licensee's initial response to the staff indicated that the source term was not increasing, therefore, there was no need to evaluate against the criteria in Section 11.4A. However, this response does not address the potential for flammable/explosive gas buildup inside the bunkers.

   In a 2014 teleconference, the staff asked the licensee about the potential for flammable/explosive gas buildup inside the bunkers and the licensee indicated that no resin would be stored in the radwaste building (or in the bunkers). Therefore, the licensee stated that there was no risk of flammable/explosive gas buildup inside the bunkers.

   However, instead of indicating that no resin will be stored in the bunkers, in an August 2015 submittal (S3 to LAR 13-09) and again in a December 2015 submittal (R1 to LAR 13-09), the licensee indicated that explosive/flammable conditions were not a concern because it was not a concern in the AP1000 design. This is not an acceptable response because the AP1000 DCD did not include bunkers. The inclusion of bunkers is a departure from the AP1000 design and provides an enclosed location where flammable/explosive gases from stored radioactive material could achieve flammable/explosive concentrations.

   Therefore, as a result of a February 2016 teleconference, staff asked the licensee to revise the response to either indicate that resin wouldn't be stored in the bunkers, to provide information indicating the bunkers were ventilated, so gas buildup would not be a concern, or to provide an analysis indicating why the design is acceptable.

   In LAR 13-09, Revision 1, Supplement 1 (June 2016), the licensee indicated that the highest activity resins expected to be stored in the bunkers were condensate polishing system resin and steam generator blowdown system electrodeionization module resin. In addition, the licensee indicated that if the maximum amount of condensate polishing system and steam generator blowdown system electrodeionization unit resin that could be generated over one year of operation, assuming 0.25% failed fuel and design basis primary to secondary leakage, is stored in a radwaste bunker for a period of six months,

hydrogen gas concentrations will not exceed 5 volume percent (in the response, the licensee indicates that the calculated hydrogen concentration during these conditions after 6 months is 4.7 volume percent). The licensee also added information to UFSAR Chapter 11 specifying that a new evaluation would be needed to confirm the risk of hydrogen gas generation if the total volume, activity, or storage period was larger than the quantities assumed. The licensee specified that the new evaluation would need to demonstrate that the hydrogen concentration in the bunker air space will not exceed 5 percent hydrogen in air, per NUREG/CR-6673. Based on this response, staff requests the following:

a. The above guidance specifies the possibility of other flammable/explosive gasses being generated besides only hydrogen (such as methane). In addition, other processes can generate flammable/explosive gasses beyond just radiolytic gas generation. However, the information provided by the licensee only considered the generation of radiolytic generation of hydrogen gas as a source of potentially explosive gases. Information Notice 90-050, “Minimization of Methane Gas in Plant Systems and Radwaste Shipping Containers - ML08261039,” discusses an event where methane gas accumulated in radioactive waste containers due to microbial activity. Other NRC documents, such as RIS 2008-12, “Considerations For Extended Interim Storage Of low Level Radioactive Waste By Fuel Cycle And Materials Licensees,” and industry documents such as EPRI report 1018644 “Guidelines for Operating an Interim On Site Low Level Radioactive Waste Storage Facility – Revision 1,” note that waste material interactions, including decomposition of organic resins can lead to gas generation.

   Perform a review of all applicable waste forms to be stored within the bunkers and ensure that other forms of potentially flammable/explosive gasses besides hydrogen are considered and that all processes for gas generation beyond radiolysis (such as biodegradation and chemical) are appropriately considered. If there is no potential for other processes generating flammable/explosive gasses, beyond radiolysis, please justify why it is not necessary to consider gas generation from other processes and include information in the FSAR explaining why they need not be considered for the waste stored in the bunkers.

b. The use of 5% hydrogen in NUREG/CR-6673 is for transportation packages in transport. The 5% concentration limit in NUREG/CR-6673 is based on hydrogen flammability limits inside transportation packages only. Since the bunkers are not a transportation package, the guidance specifying a 5% limit is not applicable. The normal flammability limit for hydrogen in air is 4%. In addition, for safety-related systems, Branch Technical Position (BTP) CMEB-9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants," specifies controls to maintain hydrogen concentration less than 2 percent for SSCs evaluated using the BTP as guidance. Please specify why the hydrogen concentration limit of 5% is appropriate for the hydrogen concentration limit in the bunkers or modify the limit to a value below the flammability limit, with sufficient conservatism to ensure the flammability limit is not reached or revise the hydrogen concentration limit to a more conservative value.

c. It is unclear if the procedures discussed in the LAR will be covered under part of the radiation protection program or if this is part of a separate program. Please specify what program will include these procedures and update the UFSAR as appropriate.

d. In addition to the above, the staff requests to review the licensee's completed calculations, when the above issues have been addressed.

e. As an alternative to items a through d above, the licensee may add ventilation lines to each of the bunkers and provide information on the ventilation capabilities and requirements for each of the bunkers, demonstrating that the ventilation is adequate to prevent the buildup of flammable/explosive conditions from the waste being stored in the bunkers.

2. SRP 11.4A specifies that "Facility design and operation should assure that radiological consequences of design basis events (e.g., fire, tornado, seismic occurrence, and flood) do not exceed a small fraction (10 percent) of 10 CFR Part 100 dose limits (i.e., no more than a few sieverts whole body dose)." In previous versions of LAR 13-09, the licensee indicated that the total source term within the Radwaste Building was not increasing due to the LAR and therefore, there was no need to evaluate against this criteria. The licensee removed this information from the current revision of the LAR. In addition, the current version of the LAR indicates the possibility for higher dose rates than were specified in previous versions. For example, the licensee now indicates that 4.5 inches of steel shielding, plus credit for the roof thicknesses and distance between the waste storage location and the roof elevation is needed to maintain the dose rate at Zone III on the roof. The waste accumulation room was Zone IV prior to the LAR. This amount of shielding would not be necessary to shield a Zone IV radiation area to a Zone III area. In addition, the licensee also indicates that, in reality, the steel shield bunker roof plate is 6 inches and that two 6 inch plates may be used, if necessary. Therefore, it appears, based on the most recent version of LAR 13-09, that the source term in the Radwaste Building is larger than the source term that was initially approved in the UFSAR. As a result, the licensee is requested to demonstrate how the design and operation will assure that the radiological consequences of design basis events (e.g., fire, tornado, seismic occurrence, and flood) do not exceed a small fraction (10 percent) of the 10 CFR Part 100 dose limits.

<u>SCE&G Response to New RAI Question 11:</u>

1a. Possibility of "other flammable / explosive gases" vs. just H2

Radiolysis: It is acknowledged that NUREG/CR 6673 discusses the possibility of generation of hydrogen as well as other flammable / explosive gasses due to radiolysis. Table 3.1 of NUREG/CR 6673 provides reasonable bounding experimentally measured G values (defined as molecules of *flammable gas* per 100ev of absorbed energy) for hydrogen and flammable gas under the columns titled G(H2) and G(flam gas) as a result of radiolysis of materials commonly found in radwaste.

The AP1000 analysis performed to address radiolytic generation of hydrogen in the radwaste building bunkers due to storage of spent secondary side resin (specifically, resin from the condensate polishing system (CPS) demineralizers and electrodeionization (EDI) demineralization units supporting cleanup of the steam generator blowdown), used a G value of 1.7 molecules / 100 eV. The referenced G value is listed in Table 3.1 of NUREG/CR 6673 as bounding for resin media under the "hydrogen" column, as well as the "flammable gas" column, thus promoting the concept that "other flammable gases" formed by radiolysis in resin are *insignificant* in comparison to Hydrogen.

The referenced AP1000 analysis assumes that structural material used in packaging the resin prior to storage in the radwaste bunker would have G values less than or equal to the bulk of the waste, i.e., the resin (G-value of 1.7). This is a reasonable assumption since the resin will be stored in 55 gallon drums (carbon steel, G value = 0). Materials that may have higher G-values (such as polyethylene liners or epoxy coatings inside the 55 gallon drums) are expected to be small contributors to hydrogen generation due to their "low mass fraction". Based on engineering judgment, the associated contribution would be insignificant especially when taking into consideration the conservative assumptions used in this analysis (such as "all of the energy from decay of radioactivity on the resin will be utilized to generate hydrogen")

<u>Other Processes that could generate flammable gases:</u> IE Notice 90-50 focuses on methane production due to bacteria interacting with the "cellulose" of the filter-demineralizered resin (powdex) embedded in its cellulosic substrate. The AP1000 CPS and EDI systems utilize "resin beads" which do not have the "cellulose" component that could support the growth of bacteria and methane production.

The conclusions of BNL-NUREG-40867, a paper presented in Waste Management 1988 CONF-880201-30, titled "Biodegradation of Ion-Exchange Media" by B.S. Bowerman, J.H. Clinton, S.R. Cowdery, Brookhaven National Laboratory, (conducted under the auspices of the NRC) indicates that a "mixed microbial culture can be grown from actual ion-exchange resin wastes *provided nutrient salts, a secondary source of carbon and excess water are added to the waste*." The above is not representative of the resins stored in the AP1000 radwaste bunkers.

RIS 2008-12 recommends that if radioactive waste is being stored, an assessment needs to be made of whether decomposition and chemical reactions of incompatible waste materials can generate gas or other reaction products over time, and that appropriate measures are taken to mitigate the consequences of these reactions.

The radwaste bunkers were included into the design of the AP1000 Radwaste Building to allow the segregation of materials with radioactivity content higher than the dry active waste (DAW) that is typically expected to be stored in this area. The bunkers are expected to contain dewatered secondary side spent resin and miscellaneous contaminated / activated components or tools exhibiting medium to high levels of radioactivity that reflect the isotopic activity limits imposed by the Category IIc design of the Radwaste Building and are limited by the radiation

zoning requirements of adjacent spaces. Based on the listed waste forms intended to be stored in the bunkers, it is reasonable to conclude that flammable gas production due to waste material interactions due to chemistry or decomposition during the 12 month storage period is not likely. EPRI Report 1018644, Revision 1 focuses on guidelines for operating an interim on-site Low Level Radioactive Waste Storage Facility. Section 1.4 of the referenced report indicates that the term “interim storage,” as used in the report “refers to storage within existing or planned interim on-site LLW Facilities”. The report states that it is “not intended to be used for control of radioactive material that is temporarily stored or staged for reuse”. Based on the applicability statement present in the report, it is concluded that it is not applicable to the temporary storage of radwaste material in the AP1000 Radwaste Building waiting for final packaging.

LAR 13-09 R1 S1 (reference 7) Enclosure 19 text for UFSAR subsection 11.4.2.5.2, pages 10 and 11 of 14, discussing explosive gas generation is updated to explain how hydrogen was selected as the most credible source, see page 14 of this enclosure for the change.

1b. Basis for using 5% volume percent hydrogen in air as the lower flammability limit for H2

Section 4.4.1.1 of NUREG/CR 6673 “Hydrogen Generation in TRU Waste Transportation Packages” indicates that various experiments were performed to determine lower and upper flammability limits for hydrogen in air in a reaction chamber. There is no indication that any credit was taken for outleakage as a result of transport cask design, thus making the experiment applicable for any non-ventilated area. Based on the above, the results of the experiment were considered appropriate for the 10ft by 10ft by 10ft AP1000 radwaste bunkers. Section 4.4.1.1 goes further to indicate that “ignition at the top of the chamber (downward flame propagation) resulted in different results for the flammability limits compared with igniting the gases from the bottom of the chamber (upward flame propagation). In summary, per NUREG/CR 6673, Section 4.4.1.1:

- For upward flame propagation the lower flammability limit was 4.1 volume percent hydrogen in air
- For horizontal flame propagation the lower flammability limit was 6.7 volume percent hydrogen in air
- For downward flame propagation the lower flammability limit was 9 volume percent hydrogen in air

The above conclusion is similar to that documented Regulatory Guide 1.7, Revision 2, Section B which discusses experiments performed by the Bureau of Mines at its facilities with initial hydrogen volume concentrations on the order of 4 to 12 volume percent. The NRC concludes that in the “…range of 4 to 6 percent, the rate of flame propagation is less than the rate of rise of the flammable mixture. Therefore, the flame can propagate upward, but not horizontally or downward.”

The AP1000 radwaste bunkers can only be opened from the top or the side which would provide the potential location for a source for ignition thus resulting in either a downward flame propagation (limit of 9%) or a horizontal flame propagation (limit of 6.7%), respectively. Thus the scenario of upward flame propagation (limit 4.1%) was deemed not credible for the radwaste bunkers. In addition, Section 4.4.1.1 of NUREG/CR 6673 goes on to state that 5 volume percent hydrogen is considered appropriate as a lower flammability limit based on the methods

presented which are intended to provide a simplified analytical approach that is adequately conservative.

The above rationale was used in the initial response provided to the NRC which utilized a lower flammability limit acceptance criteria of 5 volume percent hydrogen in air.

It is agreed that the nuclear industry has conservatively applied a lower flammability limit acceptance criteria for hydrogen in air of 4% when addressing control of combustible gas concentrations in containment following a *Loss-of-Coolant Accident*. Regulatory Guide 1.7, Revision 2, Section B recommends a lower flammability limit of 4 volume percent of hydrogen in air or steam-air atmospheres on the basis that it is well established and is adequately conservative.

In response to this RAI and for purposes of additional conservatism, the AP1000 analysis performed to address radiolytic generation of hydrogen in the radwaste building bunkers due to storage of spent secondary side resin has been reviewed to assess the impact of lowering the lower flammability limit acceptance criteria from 5 to 4 volume percent of hydrogen in air. Summarized below are the currently reported Cases and associated results presented in the referenced AP1000 analysis. All the Cases analyzed reflect design basis radiation source terms based upon fuel defects in the rods producing 0.25% of the core power and with coincident primary to secondary leakage of 300 gallons/day. The activity accumulated on the resin reflect 1 cycle of operation.

- Case 1 represents 12 month storage in a single bunker in the AP1000 Radwaste building of the "as-designed" total volume of spent resin in the two (2) CP units and the two (2) EDI units that are typically on-line (i.e., 496 ft^3 of CPS resin and associated membranes + 11 ft^3 of EDI resin and associated membranes). The results indicate that for this Case the concentration of hydrogen in the bunker *does not exceed* 4% volume percent of hydrogen in air.

- Case 2 represents 12 month storage in a single bunker in the AP1000 Radwaste building of the annual volume of solid radwaste estimated for CPS and EDI resin as provided in UFSAR Table 11.4-1 (i.e., 206 ft^3 of CPS resin + 540 ft^3 of EDI resin and associated membrane). Note 6 to UFSAR Table 11.4-1 states that the estimated volume of 540 ft^3 assigned to the steam generator blowdown material (resin and membrane) is conservative and based on removal of both EDI units (inclusive of the associated resin and membrane contents). Thus use of 540 ft^3 in this Case as the anticipated amount of EDI resin and membrane is very conservative. The results indicate that for this conservative Case the concentration of hydrogen in the bunker *exceeds* 4% volume percent of hydrogen in air. For operational purposes, Case 2 is not credible and thus not included in the determination of compliance with the 4% hydrogen limit.

- Case 3 represents 12 month storage in a single bunker in the AP1000 Radwaste building of 540 ft^3 of EDI resin and associated membranes. This case is intended to reflect the eventuality of removing both EDI units (inclusive of the associated resin and membrane contents) and storing them in a single bunker. The results indicate that for this Case the concentration of hydrogen in the bunker *does not exceed* 4% volume percent of hydrogen in air.

- Case 4 determined the minimum free volume required in a AP1000 Radwaste building bunker to ensure a hydrogen concentration below 5% volume percent of hydrogen in air

assuming 1-cycle worth of EDI and CPS spent resin was stored in the bunker for 12 months. The analysis reports a required bunker free volume of 335 ft^3.

Based on the above it is concluded that a lower flammability limit acceptance criteria of 4 volume percent of hydrogen in air will be met for the following two scenarios:

i. 12 month storage in a single bunker in the AP1000 Radwaste building of the "as-designed" total volume of spent resin in the two (2) CP units and the two (2) EDI units that are typically on-line (i.e., 496 ft^3 of CPS resin and associated membranes + 11 ft^3 of EDI resin and associated membranes)

ii. 12 month storage in a single bunker in the AP1000 Radwaste building of both EDI units (inclusive of the associated resin and membrane contents).

In addition, it can be concluded, that with a reduced lower flammability limit acceptance criteria of 4 volume percent of hydrogen in air, a required bunker free volume of 423 ft^3 is needed to store 1-cycle worth of EDI and CPS spent resin for 12 months. This updated estimate for the required free volume in a AP1000 radwaste bunker is developed using the methodology outlined in the referenced AP1000 analysis which incorporates the use of the following equation, and a lower flammability limit acceptance criteria of 4 volume percent of hydrogen in air:

$V = (0.96 \times n_{H2} / 0.04) \times (R_g T_0 / P_o)$

Where

V = non-leaking enclosure void volume, cm^3

n_{H2} = Number of moles of hydrogen gas generated, gmol

R_g= Universal gas constant, 82.05 cm^3-atm/gmol-^oK

T_0 = Temperature when the non-leaking enclosure was sealed, ^oK

P_0 = Pressure when the non-leaking enclosure was sealed, atm

The following information is provided to respond to the question of applicability of the criteria presented in Branch Technical Position (BTP) CMEB-9.5-1, which specifies controls to maintain hydrogen concentration to less than 2 percent for SSCs evaluated using the BTP as guidance

- Review of BTP CMEB 9.5-1 indicates that a) routing of "hydrogen lines" in "safety related areas" should take into consideration that in case of a line break, the hydrogen concentration in the affected areas should not exceed 2% and b) that the ventilation systems in battery rooms should be capable of maintaining the H2 concentration to below 2 volume % . There are no other stipulations.

- Table 9.5.1-1 of the UFSAR (summarizes compliance to BTP CMEB 9.5-1) commits to a ventilation system in the battery rooms that is capable of maintaining hydrogen concentrations below 2 percent. Table 9.5.1-1 provides no hydrogen concentration related commitment for any other spaces.

Based on the above it is concluded that:

- Since the radwaste bunkers are not in an area that has SSC, the 2 volume percent of hydrogen in air criteria, is not applicable, and that the previously proposed limit of 4 volume percent of hydrogen in air may be used.

- Though not credited in the AP1000 analysis, the bunkers are not "leak tight", so any generated hydrogen will most likely escape into the radwaste building and be captured and removed by the ventilation system.

LAR Updates

Based on the response above, LAR13-09 R1 S1 (reference 7) Enclosure 17 Section 3.2, the quoted text from page 13 & 14 of 23 is revised as follows to discuss 4 volume percent rather than 5. An insert is provided to replace some of the existing text, and other changes are also provided throughout the excerpt:

> "Evaluation of Potential for Radiolytic Hydrogen Gas Generation in the Bunkers
>
> …The acceptance criteria for the evaluation is a calculated hydrogen concentration in the radwaste building bunker air space less than 4 volume percent hydrogen in air.
>
> This evaluation included the following cases:
>
> [Blue text above from this response is inserted here to replace existing text]
>
> Controls to Prevent Excess Radiolytic Hydrogen Gas Generation in the Bunkers
>
> To address the results of this evaluation, changes are proposed to UFSAR Subsection 11.4.2.5.2 to describe the controls established in order to prevent the potential for creation of a hazard from radiolytic hydrogen gas generation. The evaluation confirms no exceedance of 4 volume percent hydrogen in air based on the conservative two limiting scenarios discussed above. The scenarios assume the bounding amount of CPS and EDI resins that could be generated over one cycle of operation and then stored in a single unventilated bunker for one year. A clarification is also added to note, although the analysis conservatively focuses on storage in a single bunker, during operation all three bunkers will be available for use. In addition, changes are proposed to UFSAR Subsection 11.4.2.5.2 to refer to the administrative controls described in UFSAR Subsections 11.2.1.2.5.2 and 13.5.2.2.5 that limit the total cumulative radioactive inventory of unpackaged wastes located in the radwaste building to prevent exceeding the Regulatory Guide 1.143, Revision 2, unmitigated radiological release criteria, and 10 CFR Part 20.1301 dose limit. These other administrative controls further restrict the amount and activities of resins that are allowed to be stored in the bunker. Should there be a need to store resins with total volume or activity higher than that of the evaluated resins, or for a longer storage period, a new evaluation would be needed to confirm the risk associated with potential hydrogen gas generation by demonstrating that the hydrogen concentration in the bunker air space will not exceed 4 volume percent hydrogen in air."

LAR 13-09 R1 S1 (reference 7) Enclosure 19 text for UFSAR subsection 11.4.2.5.2, pages 10 and 11 of 14, discussing explosive gas generation is updated to explain how hydrogen was selected as the most credible source and to state that the bunker air space will not exceed 4 volume percent hydrogen. As discussed above, Case 2 is very conservative with respect to the amount of resin available to be stored for a year into a single bunker following one cycle of operation. For operational purposes, Case 2 is not credible and thus not included in the determination of compliance with the 4% hydrogen limit. A clarification is also added to the UFSAR, to describe that although the analysis conservatively focuses on storage in a single bunker, during operation all three bunkers will be available for use.

The UFSAR text is revised as follows:

> "The bunkers have been evaluated for hydrogen gas generation resulting from the temporary storage of resin, specifically condensate polishing system (CPS) resin and steam generator blowdown system electrodeionization (EDI) unit resin. Hydrogen was selected as the most credible source of explosive gas generation. Based on table 3.1 of NUREG/CR 6673 other flammable gases formed by radiolysis in resin are insignificant in comparison to Hydrogen. Methane was also considered, but was found not to be a credible source because the AP1000 CPS and EDI systems utilize resin beads which do not have the cellulose component that could support the growth of bacteria and methane production. Generation of flammable gases by processes such as biodegradation, decomposition and waste material interaction due to chemistry, was also determined to not be credible based on the waste forms intended for storage in the AP1000 radwaste bunkers; i.e., secondary side spent resin, and miscellaneous contaminated / activated components or tools.
>
> The evaluation assumes two storage scenarios of the bounding amounts of CPS and EDI resins expected to be generated over one cycle of operation and then stored in a single, unventilated bunker for one year. The scenarios result in a maximum hydrogen concentration of less than 4 volume percent hydrogen in air, and conclude that there is no risk of radiolytic hydrogen gas generation that could result in the creation of a hazard within the stated assumptions. Although the evaluation is focused on storing a bounding amount of resin into only one bunker, all three bunkers are available for use.
>
> The existing administrative controls in subsections 11.2.1.2.5.2 and 13.5.2.2.5 limit the total cumulative radioactive inventory of unpackaged wastes allowed in the radwaste building and bunkers, and the existing radiation zoning and access requirements in subsection 12.3.1.2 further restrict the amount and activities of resins that are allowed to be stored in the bunker. Therefore, a new evaluation for hydrogen gas generation resulting from the temporary storage of resin would only be needed in the unlikely event that storage of resins with total volume or activity higher than that of the evaluated resins, or for a longer storage period, is desired. The new evaluation would be needed to confirm the risk associated with potential hydrogen gas generation by demonstrating that the hydrogen concentration in the bunker air space will not exceed 4 volume percent hydrogen in air."

1c. Request to specify if the procedures discussed in the LAR will be covered under part of the radiation protection program or a separate program. Specify the Program where the procedures discussed in the LAR will be incorporated and to update the UFSAR accordingly.

The procedures have not been developed yet but the controls discussed in UFSAR Subsections 11.2.1.2.5.2, 11.4.2.5.2 and 13.5.2.2.5 will be part of the "Maintenance and Other Operating Procedures" discussed in UFSAR Subsection 13.5.2.2. The operating procedures are also called out in UFSAR Subsection 12.1.3 and 12.1.4, which discuss "Operational Considerations". These sections are tied to Section 12AA, which puts them under the umbrella of the radiation protection program discussed in 12AA and Table 13.4-201, accordingly no additional markup has been proposed for UFSAR Subsections 11.2.1.2.5.2, 11.4.2.5.2 and 13.5.2.2.5.

1d. Request for review the of the licensee's completed calculations, when the above issues have been addressed.

The explosive gas generation calculation was made available for review in an NRC Audit on November 15, 2016.

1e. As an alternative to items a through d above, the licensee may add ventilation lines to each of the bunkers.

Based on the responses provided to NRC RAI Question 11.1a and 1b, it is the opinion of the licensee that ventilation lines are not required for the AP1000 Radwaste bunkers.

2. Maintaining Dose Limits

The total source term within the Radwaste Building is not increasing. As discussed during the public meeting on 6/30/2016, this confusion about the total source term resulted from the wording at the end of the response to previous RAI Question 12 as captured in Enclosure 16 of LAR 13-09 R1 S1 (reference 7).

The response stated:

"This response superseded previous responses to RAI Question 6b initially provided in LAR 13-09 Supplement 3."

The response to RAI Question 12 as discussed in LAR 13-09 R1 S1 superseded only the portion of the previous response to RAI Questions 6b pertaining to explosive gas generation initially provided in LAR 13-09 S3 (reference 5).

The response to New Question 10 above provides details on the basis for the radiation levels on the roof and how it complies with Section 20.1301 (e) of 10 CFR Part 20. The response also describes the use of 6″ plates as opposed to the designed 4′ 1/2″ plate as an extra conservatism and for ALARA purposes and not because of an increase in the total source term in the Radwaste Building.

South Carolina Electric and Gas Company

Virgil C. Summer Nuclear Station (VCSNS) Units 2 and 3

NND-16-0414

Enclosure 21

Editorial updates

(LAR 13-09 R1 S2)

(This Enclosure consists of 2 pages, including this cover page.)

The following editorial updates are incorporated into the LAR.

LAR13-09 R1 S1 (reference 7) Enclosure 17:

Section 3.2, page 9 of 23

The word “operational” is revised to “occupational”

LAR13-09 R1 S1 (reference 7) Enclosure 17:

Section 3.2, page 15 of 23

The word “reasonable” is revised to “reasonably”

LAR13-09 R1 S1 (reference 7) Enclosure 19:

Page 2, 3 & 4 of 14

The word “Tier 1” is revised to “Tier 1 and corresponding COL Appendix C”

LAR13-09 R1 S1 (reference 7) Enclosure 19:

Page 10 of 14

The word “cubicfeet” is revised to “cubic feet”