



May 16, 2013

RC-13-0006

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555-0001

Dear Sir/Madam:

Subject: VIRGIL C. SUMMER NUCLEAR STATION (VCSNS) UNIT 1
DOCKET NO. 50-395
OPERATING LICENSE NO. NPF-12
PATH FORWARD FOR RESOLUTION OF GENERAL SAFETY ISSUE (GSI)-191

- References:
1. Generic Letter (GL) 2004-02: Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors
 2. December 23, 2010, Staff Requirements – SECY-10-0113 – Closure Options for Generic Safety Issue - 191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance
 3. October 12, 2011, Pressurized Water Reactor Owners Group (PWROG), Topical Report (TR) WCAP-16793-NP, Revision 2, "Evaluation of Long-Term Core Cooling Considering Particulate Fibrous and Chemical Debris in the Recirculating Fluid"
 4. May 4, 2012, Nuclear Energy Institute (NEI) to the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation, Director, Division of Safety Systems – Subject: GSI-191 – Current Status and Recommended Actions for Closure
 5. July 9, 2012, SECY-12-0093 – Closure Options for Generic Safety Issue – 191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance
 6. November 15, 2012, Nuclear Energy Institute (NEI) to the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation, Director, Division of Safety Systems – Subject: GSI-191 – Revised Schedule for Licensee Submittal of Resolution Path
 7. November 21, 2012, Nuclear Regulatory Commission Review of Generic Safety Issue-191 Nuclear Energy Institute Revised Schedule for Licensee Submittal of Resolution Path.

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8. December 14, 2012, Staff Requirements – SECY-12-0093 – Closure Options for Generic Safety Issue-191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance
9. April 8, 2013, Final Safety Evaluation for Pressurized Water Reactor Owners Group Topical Report WCAP-16793-NP, Revision 2, "Evaluation of Long-Term Cooling Considering Particulate Fibrous and Chemical Debris in the Recirculating Fluid"

South Carolina Electric & Gas Company, acting for itself and as an agent for South Carolina Public Service Authority hereby submits its path forward for resolution of Generic Safety Issue (GSI)-191. In its May 4, 2012 letter to the NRC, the Nuclear Energy Institute (NEI) highlighted the current industry status for GSI-191 and recommended actions for closure of GSI-191, which were based on licensees providing a docketed submittal to NRC by December 31, 2012, that would outline a GSI-191 resolution path and schedule pursuant to the Nuclear Regulatory Commission (NRC) direction (Reference 2). By Reference 6, NEI recommended to the NRC that licensees delay submittal of GSI-191 resolution path and schedule until January 31, 2013, or 30 days following placement of both the NRC response to SECY-12-0093 and the NRC staff safety evaluation (SE) on Topical Report (TR) WCAP-16793-NP, Revision 2. On December 14, 2012, the NRC approved the staff's recommendation in SECY-12-0093 to allow licensees the flexibility to choose any of the three options discussed in the paper to resolve GSI-191. Further, the NRC encouraged NRC staff to remain open to staggering licensee submittals and the associated NRC reviews to accommodate the availability of staff and licensee resources. The SE for TR WCAP-16793-NP, Revision 2 was made publicly available by the NRC on April 16, 2013.

An industry template was developed by NEI for the identification of a resolution path and schedule and to describe defense-in-depth and mitigation measures to support the proposed resolution schedule.

The NEI template was used for the development of Attachment I for VCSNS and provides a resolution path forward and schedule for resolution, summary of actions completed for Generic Letter 2004-02, and defense-in-depth and mitigation measures which will be established and maintained throughout the resolution period.

This letter contains six (6) new regulatory commitments that will achieve closure of GSI-191 and address GL 2004-02. The new regulatory commitments are outlined in Attachment II.

If you have any questions regarding this submittal, please contact Mr. Bruce L. Thompson at (803) 931-5042.

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

5-16-2013
Executed on


Thomas D. Gatlin

TS/TDG/wm

Attachment I: Closure Option for Generic Safety Issue 191 (GSI-191), "Assessment of
Debris Accumulation on Pressurized Water Reactor Sump Performance"

Attachment II: List of Regulatory Commitments

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**VIRGIL C. SUMMER NUCLEAR STATION UNIT 1
DOCKET NO. 50-395
OPERATING LICENSE NO. NPF-12**

ATTACHMENT I

**CLOSURE OPTION FOR GENERIC SAFETY ISSUE 191 (GSI-191), "ASSESSMENT
OF DEBRIS ACCUMULATION ON PRESSURIZED WATER REACTOR SUMP
PERFORMANCE"**

1.0 Introduction

South Carolina Electric and Gas Company (SCE&G) has selected Option 2 and intends to pursue refinements to evaluation methods and acceptance criteria as a part of the PWROG testing program. To support use of this path, and continued operation for the period required to complete the necessary analysis and testing, SCE&G has evaluated the design and procedural capabilities that exist to identify and mitigate in-vessel blockage. A description of these detection and mitigative measures is provided in Section 9, "Summary of Defense-In-Depth (DID) Measures." Additionally, a summary of the existing margins and conservatisms that exist for V. C. Summer Nuclear Station (VCSNS) are also included in this document.

2.0 Characterization of Current Containment Fiber Status

From the debris generation and debris transport analysis, SCE&G has identified two separate fibrous debris loading cases: Marinite XL insulation and TempMat.

The design limiting case for strainer head loss involves Marinite XL insulation. The Marinite XL is 5 percent by weight mineral wool (Table 6B-2, Reference 3). As documented in References 1 through 4, the Marinite XL insulation case total fiber load at the sump strainers is as follows.

Mineral Wool from Marinite XL	19.8 pounds
Latent Fiber inside Containment	16.0 pounds
Total Fiber Load at the Strainer	35.8 pounds

The second fiber loading case is from TempMat insulation. The TempMat fiber is transported to Train A and Train B strainers (Table 5-1, Reference 3). While not limiting for strainer head loss (Reference 4), the TempMat case has a higher fiber load. The TempMat insulation case total fiber load at the sump strainers is as follows.

TempMat to Strainer A	35.8 pounds
TempMat to Strainer B	22.1 pounds
Latent Fiber inside Containment	16.0 pounds
Total Fiber Load at the Strainer	73.9 pounds

SCE&G previously performed strainer bypass testing as detailed in response to RAI Number 11 (Reference 3). The tested bypass fraction for Marinite fiber was 0.7 percent of total fiber. NRC staff had concerns with the test protocol and SCE&G agreed to use a value of 5 percent total bypass. Taking no credit for RB spray flow split and using the maximum fiber load from the TempMat case, approximately 3.7 pounds (5 percent multiplied by 73.9 pounds) of fibrous debris would bypass the sump screen and enter the reactor vessel. With 157 fuel assemblies, the quantity of fiber reaching the reactor fuel is 10.7 grams per fuel assembly (3.7 pounds per 157 assemblies multiplied by 454 grams per pound).

Although the calculated value appears to meet the limits specified in WCAP-16793, Rev. 2, the fiber bypass test procedure that was used was not consistent with the Draft NEI guideline (Reference 18). As a result, SCE&G is participating in the PWROG comprehensive program to

develop new acceptance criteria for in-vessel debris. The above determined value of in-vessel fiber supports a reasonable assurance for continued operation during the interim time period. At the time the PWROG establishes new in-vessel acceptance criteria, SCE&G will develop a plan for demonstrating compliance with the PWROG program limits and communicate the plan to the NRC within 60 days of the PWROG establishing new in-vessel acceptance criteria.

3.0 Characterization of Strainer Head Loss Status

SCE&G previously provided the results of strainer head loss testing, including the impact of chemical effects, in References 1 through 5. The results of this testing demonstrate acceptable results with regard to allowable head loss.

4.0 Characterization of In-Vessel Effects

SCE&G intends to follow the resolution strategy proposed by the Pressurized Water Reactor Owners Group (PWROG) for establishing in-vessel debris limits for the type of plant design that exists at VCSNS.

5.0 Licensing Basis Commitments

SCE&G currently has a commitment to provide the NRC with closure of in-vessel effects in response to requests for additional information (RAIs) (RAI Number 23 in Reference 3):

“SCE&G is a part of the WOG program developing WCAP-16793-NP and has supplied debris loading to Westinghouse. SCE&G will demonstrate that in-vessel downstream effects issues are resolved for V.C. Summer by showing that V.C. Summer conditions are bounded by the final WCAP-16793-NP and the corresponding final NRC staff SE, and by addressing the conditions and limitations in the final SE. This response will be supplied within 90-days of the NRC SE on the WCAP-16793-NP.”

As a result of the remaining open questions associated with GL 2004-02 for VCSNS, and the information contained within this document, the previously established commitment is considered to be closed based on the intended direction to be taken as described in this document. New commitments as a result of this document are described in Attachment II.

6.0 Resolution Schedule

SCE&G will achieve closure of GSI-191 and address GL 2004-02 per the following schedule.

- Procedural updates to address core blockage to support Defense-in-Depth measures will be completed by July 1, 2014.
- Engineering walk downs, as needed, for potential insulation replacement or remediation. These walk downs will be completed during Refuel Outage 21 in the spring of 2014. Laser scans from previous outage work will be used for this assessment as well.

- Comparison of plant specific core fiber loading with the PWROG Comprehensive Analysis and Test Program for GSI-191 Closure is currently scheduled for May of 2014 (Reference 19). At the time the PWROG establishes new in-vessel acceptance criteria, SCE&G will develop a plan for demonstrating compliance with the PWROG program limits and communicate the plan to the NRC within 60 days of the PWROG establishing new in-vessel acceptance criteria.
- Within six months of establishing a final determination of the scope of potential insulation replacement or remediation SCE&G will submit a final updated supplemental response to support closure of GL 2004-02 for VCSNS.
- SCE&G will update the current licensing basis (FSAR) following NRC acceptance of the updated supplemental response for VCSNS and completion of the identified removal or modification of insulation debris sources in containment per plant modification procedures and processes (10 CFR 50.71(e)).
- If SCE&G determines that a proposed testing or analysis resolution path will not be viable, then an alternate resolution path will be discussed with the NRC to gain acceptance of the proposed path and to establish an acceptable completion schedule.

7.0 Summary of Actions Completed to Address GL 2004-02

To support closure of GSI-191 and to address GL 2004-02, SCE&G has completed the following actions for VCSNS:

- The original strainers had a surface area of 23 square feet for each of four pumps (Reference 20), with nominal 1/4 inch square openings (Reference 15). The strainers were replaced with Atomic Energy of Canada Limited (AECL) fin type strainers having surface areas of 2380 square feet and 2939 square feet, with nominal 1/16 inch circular openings (Section 3j of Reference 1).
- The 12 High Head Safety Injection (HHSI) Throttle Valves were replaced during the Fall 2006 Refueling Outage with FloServe Pressure-Combo valves. These valves feature an outlet flow nozzle which takes up most of the required pressure drop for the flow balance, permitting the valve to have adequate clearance for the downstream effects. The downstream effects analysis for the valves is complete. Erosion is less than the 3 percent allowable. The minimum valve opening based on the Emergency Core Cooling System (ECCS) flow balancing criteria is approximately 3/32 inches compared to the 1/16 inches screen openings. (Reference 1)
- Two Vertical Trash Rack Gates are provided in the Reactor Building (RB) Annulus on the 412 foot elevation. The gates are located on either side of the recirculation sumps to stop large debris from entering the sump area. The gates have 8 inch openings to allow smaller material to pass through. The gates are a non-deterministic design feature added to enhance the sump design based on the guidance provided in Section 1.1.1.3 of

Regulatory Guide 1.82, Revision 3. No credit is taken for these gates in the GSI-191 analysis. (Reference 1)

- Alternate Source Term Loss of Coolant Accident (LOCA) Dose Analysis has been submitted and approved for V.C. Summer (Reference 7). The Down Stream Effects analysis identified a concern with pump seal backup bushings (also called disaster seals) made of graphite. Incorporating Alternate Source Term into the licensing basis has eliminated the pump seal failure from the dose analysis basis thereby addressing the concern for pump seal backup bushing failures. (Reference 1)
- Latent debris sampling was completed in 2005 and established a 105 pound load which includes a 50 percent margin. (Section 3d of Reference 1) Walk downs for unqualified material were also completed consistent with NEI 02-01. A design input of 200 square feet sacrificial area was set based on the walk downs. (Section 3b.2 of Reference 1)
- Debris generation and debris transport analyses have been completed (References 1 and 3). This included computer-aided design (CAD) modeling of reactor building and target insulation. The debris transport used computation fluid dynamic (CFD) modeling and debris transport trees to establish debris loading as the strainers.
- Ex-vessel downstream effects analysis were completed per PWROG WCAP-16406-P, Revision 1 with augmented data from WCAP-16571-P. (Section 3m of Reference 1) Application of WCAP-16571-P was reviewed and approved by the NRC. (RAI Number 22 of Reference 3 and Reference 6)
- Chemical Effects testing was completed in 2010 to address NRC RAI. Data was collected at various temperatures and flow rates. The strainer head loss supported net positive suction head (NPSH) calculations. (Reference 4)
- The Residual Heat Removal (RHR) Pump and RB Spray Pump NPSH are calculated at 70 degrees Fahrenheit consistent with the original design basis. No credit is taken for subcooling consistent with the original calculations to satisfy commitments for Regulatory Guide 1.1, Revision 0. The updated RHR and RB Spray Pump NPSH margins are as follows (Reference 4):

	Pump Flow Rate [gpm]	NPSH Required [feet]	NPSH Available [feet]	NPSH Margin [feet]
RHR Pump A	4300	17	20.2	3.2
RHR Pump B	4200	16	20.8	4.8
RB Spray Pump A	3300	17	22.1	5.1
RB Spray Pump B	3300	17	21.9	4.9

- A cumulative effects program has been established for tabulating, controlling and evaluating changes to quantities of insulation inside the RB. This included the development of a calculation listing the type, location and quantities of insulation inside the RB. (Reference 1)

- A cumulative effects program has been established for tabulating, controlling and evaluating changes to quantities of unqualified coatings inside the RB. This included the development of a calculation listing the type, location and quantities of unqualified coatings inside the RB. (Reference 1)
- VCSNS has an established Level 1 coatings program for the RB. The qualified coatings within a 4D Zone of Influence (ZOI) will also be tracked. (Reference 1)

8.0 Summary of Margins and Conservatisms for Completed Actions for GL 2004-02

The following provides a summary description of the margins and conservatisms associated with the resolution actions taken to date. These margins and conservatisms provide support for the extension of time required to address GL 2004-02 for VCSNS.

- The TempMat debris loading case has the greatest fiber load at the strainers. The transport calculations conservatively assume 10 percent erosion. As discussed in response to NRC RAI (RAI Number 3 in Reference 3), the tested erosion rates are in the 1 percent range.
- Marinite XL insulation is installed around the reactor coolant system loop piping inside the primary shield wall. With the pipe whip within the shield wall the Marinite XL is assumed to be 100 percent particulate with all fiber released. All the Marinite XL is assumed to transport to the sump strainer. (Section 3b.1.3 of Reference 1)
- The chemical debris load includes a 100 square feet operating margin out of a total of 320 square feet aluminum inside the reactor building. (Commitment Number 3 of Reference 4).
- Each of the two strainers provides a suction source for an RHR Pump and a Reactor Building Spray Pump. The flow and associated fiber to the Reactor Building Spray will not enter the reactor vessel on the first pass through the strainer.

The flow splits with two trains operating are as follows (RAI Number 16 of Reference 3).

	RHR Flow [gpm]	Spray Flow [gpm]
Train A	3669	3300
Train B	3590	3300

- In the bottom of the Reactor Vessel flow is directed up through the core and through holes in the baffle former plates. Each former plate is provided with holes so that flow travels up through the former plates (Reference 14). If flow through the core becomes restricted, flow will continue through the former plate holes and provide flow to the top of the core plate. This is depicted in Figure 1 of PWROG letter OG-12-287. (Reference 10) This core bypass flow will provide some level of core cooling.

9.0 Summary of Defense-In-Depth (DID) Measures

The following describes the plant specific design features and procedural capabilities that exist for detecting and mitigating a strainer blockage or fuel blockage condition.

Measures put in place in response to Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors," remain in place for strainer blockage. These are documented in References 8 and 9. Of specific note are:

- Refilling the Refueling Water Storage Tank (RWST) after switchover,
- Throttling RHR Pump flow when two RHR Pumps are running,
- Monitoring pump flow, discharge pressure and motor amps, and
- Implementation of Emergency Operating Procedure (EOP)-2.6 to address sump strainer blockage.

The throttling of RHR pump flow when two RHR pumps are running provides benefits by reducing flow at the strainer as well as reducing maximum flow through the core.

EOP-12.0 (Reference 11) monitors critical safety functions. EOP-12.0 is entered when transferring out of EOP-1.0 (Reference 12) such as transferring to EOP-2.0 (Reference 13) for a LOCA. EOP-12.0 monitors subcriticality, core cooling, heat sink, integrity, containment and inventory. Core cooling is monitored with Core Exit Thermocouples and Reactor Vessel Level Indication (RVLIS). EOP-12.0 directs the operator to appropriate procedures.

Additionally, the following actions are being implemented to provide further Defense-In-Depth strategies.

- EOP-14.0 (Reference 16) and EOP-14.1 (Reference 17) are entered from EOP-12.0 if inadequate core cooling is indicated. EOP-14.0 and EOP-14.1 will be updated to direct the operators to contact the Technical Support Center (TSC) when there is safety injection flow indication, but high core temperatures. The TSC will evaluate potential core blockage and advise the control room as appropriate. The updates will be completed by July 1, 2014.
- TSC guideline Plant Support Engineering Guide (PSEG)-08 will be updated. PSEG-08 includes guidance for inadequate core cooling and specific guidance for potential core blockage will be added. Recommendations on safety injection re-alignment for hot leg recirculation will be included. The updates will be completed by July 1, 2014.

Although these measures are not expected to be required based on the very low probability of an event that would challenge either the capability of the strainer to provide the necessary flow to the Safety Injection and Reactor Building Spray systems, or result in significant quantities of debris being transported to the reactor vessel that would inhibit the necessary cooling of the fuel, they do provide additional assurance that the health and safety of the public would be maintained. These measures provide support for the extension of time required to completely address GL 2004-02 for VCSNS.

10. Conclusion

The execution of the actions identified in this document will result in successful resolution of GSI-191 and closure of GL 2004-02.

11. References

1. SCE&G Letter RC-08-0031 (ADAMS Accession No. ML080640545) from Jeffrey B. Archie to Document Control Desk dated February 29, 2008, *Supplemental Response to NRC Generic Letter 2004-02: Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors*
2. NRC Letter (ADAMS Accession No. ML090270927) to Jeffrey B. Archie dated February 3, 2009, *V. C. Summer Nuclear Station - Request for Additional Information for Generic Letter 2004-02 (TAC NO. MC4721)*
3. SCE&G Letter RC-09-0134 (ADAMS Accession No. ML093360336) from Jeffrey B. Archie to Document Control Desk dated November 29, 2009, "Response to Request for Additional Information for Generic Letter 2004-02"
4. SCE&G Letter RC-10-0165, (ADAMS Accession No. ML103610171) from T. D. Gatlin to Document Control Desk dated December 17, 2010, *Follow-up Response to Request for Additional Information for Generic Letter 2004-02*
5. NRC Meeting Notes- *Summary of September 14, 2009 Public Conference Call to Discuss Responses to Generic Letter 2004-02 Requests for Additional Information (TAC No. MC4721)* (ADAMS Accession No. ML093000573)
6. NRC Memorandum E. L. Geiger to M. L. Scott, *Staff Review of WCAP-16571-P Referenced in Virgil C. Summer's GL 2004-02 Supplemental Response for Downstream Effects Evaluation of Components*, 5/17/2010 (ADAMS Accession No. ML100920035)
7. NRC Letter (ADAMS Accession No. ML102160020) to Thomas D. Gatlin dated October 4, 2010, *Virgil C. Summer Nuclear Station, Unit No. 1, Issuance of Amendment Regarding Alternative Source Term Implementation (TAC No. ME0663)*
8. SCE&G Letter RC-03-0164, (ADAMS Accession No. ML032230025) from Stephen Byrne to Document Control Desk dated August 6, 2003, *Response to NRC Bulletin 2003-01, Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors*
9. SCE&G Letter RC-04-0164, (ADAMS Accession No. ML043000231) from Jeffrey B. Archie to Document Control Desk dated October 21, 2004, *NRC Bulletin 2003-01, Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors – Request for Additional Information*

10. PWROG Letter OG-12-287, (ADAMS Accession No. ML12207A115) from Jack Stringfellow to Stewart Bailey dated July 20, 2012, *Submittal of Supplement to WCAP-16793-NP, Revision 2 (PA-SEE-0312, Revision 4)*
11. EOP-12.0, *Monitoring of Critical Safety Functions, Rev. 14*
12. EOP-1.0, *Reactor Trip/Safety Injection Actuation, Rev. 26*
13. EOP-2.0, *Loss of Reactor or Secondary Coolant, Rev. 15*
14. Drawing 1MS-07-602, Sheet 2, *3 Loop Formers, Rev. 0*
15. Drawing 1MS-05-056, *RHR & Spray Sump – Miscellaneous Erection Details, Rev. 8*
16. EOP-14.0, *Response to Inadequate Core Cooling, Rev. 16*
17. EOP-14.1, *Response to Degraded Core Cooling, Rev. 15*
18. NEI Generic Guideline, Revised DRAFT 12/7/2011, *Strainer Fiber Bypass Test Protocol*
19. PA-SEE-1090, *Comprehensive Analysis and Test Program for GSI-191 Closure, Rev. 0*
20. SCE&G Letter RC-05-0138 (ADAMS Accession No. ML052520333), from Jeffrey B. Archie to Document Control Desk dated September 1, 2005, *Response to NRC Generic Letter 2004-02: Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized Water Reactors*

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ATTACHMENT II

LIST OF REGULATORY COMMITMENTS

The following table identifies those actions committed to by SCE&G, Virgil C. Summer Nuclear Station in this document. Any other statements in this submittal are provided for information purposes and are not considered to be commitments. Please direct questions regarding these commitments to Mr. Bruce L Thompson, Manager, Nuclear Licensing, (803) 931-5042.

COMMITMENT	DUE DATE / EVENT
Procedural updates to address core blockage to support Defense-In-Depth measures	July 1, 2014
Engineering walk downs, as needed, for potential insulation replacement remediation	Refuel Outage 21 (Spring 2014)
Develop a plan for demonstrating compliance with new PWROG program limits and communicate the plan to the NRC	Within 60 days of the PWROG establishing new in-vessel acceptance criteria
Submit a final updated supplemental response to support closure of GL 2004-02	Within 6 months of establishing a final determination of the scope of insulation replacement or remediation
Update the Current Licensing Basis (FSAR)	Following NRC acceptance of the update supplemental response for VCSNS and completion of the identified removal or modification of insulation debris sources in containment per plant modification procedures and processes
Discuss alternate resolution plan with the NRC to gain acceptance of the proposed path and to establish an acceptable completion schedule	If SCE&G determines that Option 2 will not be viable