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W3F1-2013-0027

May 16, 2013

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

Subject: Closure Option for Generic Safety Issue - 191
Waterford Steam Electric Station, Unit 3 (Waterford 3)
Docket No. 50-382
License No. NPF-38

- References:
1. NRC SECY-12-0093, "Closure Options for Generic Safety Issue - 191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance," dated July 9, 2012
 2. SRM-NRC SECY-12-0093, "Closure Options for Generic Safety Issue - 191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance," dated December 14, 2012
 3. NRC letter to NEI, "Nuclear Regulatory Commission Review of Generic Safety Issue-191 Nuclear Energy Institute Revised Schedule for Licensee Submittal of Resolution Path," dated November 21, 2012

Dear Sir or Madam:

The NRC staff recommended three closure options to the Commission for resolving GSI - 191 [Ref. 1] and the Commission approved the staff's recommendation to allow licensees to choose any of the three options [Ref. 2]. The closure options included Option 2 – "Mitigative Measures and Alternate Methods Approach (Deterministic or Risk-Informed)" and Waterford 3 has selected this option to use a deterministic approach. In accordance with NRC's recommendation [Refs. 1 and 3], Waterford 3 is submitting this selected closure option and the associated implementation schedule as detailed in Attachment 1 to this letter.

There are new commitments being made in this submittal as contained within Attachment 2.

I declare under penalty of perjury that the foregoing is true and correct. Executed on May 16, 2013.

MEM/cf

DJ/MEM/sf

Attachments: 1. Closure Option 2 for Generic Safety Issue – 191
2. List of Regulatory Commitments

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Attachment 1

W3F1-2013-0027

Closure Option 2 for Generic Safety Issue - 191

Closure Option 2 for Generic Safety Issue - 191

Introduction

On July 9, 2012 the Nuclear Regulatory Commission (NRC) staff issued SECY-12-0093, "Closure Options for Generic Safety Issue - 191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance" [Ref. 1], presenting three closure options to the Commission, all of which are considered to be viable paths for resolving GSI-191. These options are: Option 1 – "Compliance with 10 CFR 50.46 Based on Approved Models," Option 2 – "Mitigative Measures and Alternate Methods Approach (Deterministic or Risk-Informed)," and Option 3 – "Different Regulatory Treatment for Suction Strainer and In-Vessel Effects (Deterministic or Risk-Informed)." The Commission approved the staff's recommendation to allow licensees to choose any of the three closure options [Ref. 2].

Waterford 3 has selected Option 2 and will use a deterministic methodology for both strainer and in-vessel effects. The deterministic resolution of strainer effects has been fully documented in previous submittals to the NRC [Refs. 3 and 4]. The deterministic resolution of the in-vessel effects will be accomplished in accordance with the resolution strategy proposed by the Pressurized Water Reactor Owner's Group (PWROG) as discussed below.

In order to support continued operation for the time period required to complete the necessary analyses, testing and plant modifications (if necessary), Waterford 3 has evaluated the design and procedural capabilities that exist to prevent, detect and mitigate sump strainer and in-vessel blockage. A summary of these prevention, detection and mitigative measures are provided later in this submittal.

Characterization of Current Containment Fiber Status

From the Debris Generation Calculation and Debris Transport Calculation, Waterford 3 has conservatively determined the fiber debris amounts that would be transported to the Waterford 3 Safety Injection (SI) Sump during a Large Break Loss of Coolant Accident (LBLOCA) is 244.4 ft³.

The SI Sump is analyzed to mitigate all size LOCAs. Based upon previously performed strainer bypass testing, the total quantity of fiber calculated to bypass the strainer is 26.69 lbs. This equates to approximately 55.8 grams/fuel assembly. The fibrous debris sources considered in these analyses include: Nukon, Transco Metal Encapsulated Insulation (MEI), and Latent Fiber.

Characterization of Strainer Head Loss Status

Waterford 3 has previously submitted the results of strainer head loss testing, including the impact of chemical effects to the NRC [Refs. 3 and 4]. This testing, together with the associated Net Positive Suction Head (NPSH) evaluations, demonstrated acceptable results with regard to allowable strainer head loss.

Characterization of In-Vessel Effects

Waterford 3 intends to follow the resolution strategy proposed by the PWROG for establishing in-vessel fiber limits. The objective of this program is to establish a range of fiber acceptance limits and applicability criteria for plant specific evaluation for GSI-191 closure by deterministic methods. The intent of the program is to improve upon the WCAP 16793-NP acceptance limit (15 grams/Fuel Assembly) that is currently applicable to all plants [Ref. 5]. The PWROG resolution strategy includes the following four Project Authorizations:

1. PA-SEE-0872, "GSI-191 Comprehensive Program Plan Support"
2. PA-SEE-1072, "Addressing Boric Acid Precipitation to Support GSI-191 Closure and EM Development"
3. PA-SEE-1088, "Independent Third-Party Review of PWROG GSI-191 Test Programs"
4. PA-SEE-1090, "Comprehensive Analysis and Test Program for GSI-191 Closure"

The resolution schedule is provided below.

Licensing Basis Commitments

Waterford 3 currently has one open commitment within the Waterford 3 commitment management system to address in-vessel downstream effects within 90 days after issuance of the NRC Safety Evaluation for WCAP-16793-NP. As a result of the remaining open issues associated with Generic Letter (GL) 2004-02 for Waterford 3, and the information contained within this submittal, the previously established commitment from a previous submittal [Ref. 4] is considered to be closed based on the intended direction to be taken as described in this submittal. New commitments as a result of this submittal are described in Attachment 2.

Resolution Schedule

Waterford 3 will achieve closure of GSI-191 and address GL 2004-02 in accordance with the following schedule.

Physical Design Changes

Investigation of insulation for possible future replacement will be performed before and during the next refueling outage for Waterford 3 which is currently scheduled for the Spring of 2014. In the event that the PWROG testing program for increasing the allowable amount of fiber per fuel assembly is not successful in increasing this limit above the plant specific values for Waterford 3, any necessary replacement or remediation of insulation will be completed by the third refueling outage following January 1, 2013 (tentatively scheduled for Spring 2017).

PWROG Program Schedule

- The PWROG resolution strategy includes testing and analysis that are planned to be conducted in accordance with the following schedules:

PA-SEE-1072, "Addressing Boric Acid Precipitation to Support GSI-191 Closure and EM Development"

- Complete testing by February 21, 2014
- Issue final WCAP by June 30, 2014

and,

PA-SEE-1090, "Comprehensive Analysis and Test Program for GSI-191 Closure"

- Complete testing by February 25, 2014
- Issue final WCAP by May 12, 2014

Licensing Basis Schedule

- Within six months of establishing a final determination of the scope of insulation replacement, remediation, or model refinements based on the results of the PWROG program, Waterford 3 will submit a final updated supplemental response to support closure of GL 2004-02 for Waterford 3. Waterford 3 expects to submit the final updated response by June 30, 2015.
- Waterford 3 will evaluate the current licensing basis within three months following NRC acceptance of the final updated supplemental response for Waterford 3. If Waterford 3 removes or modifies insulation debris sources in containment, then Waterford 3 will revise its' current license bases within six months after any refueling outage where insulation change occurs.

Summary of Actions Completed To Address GL 2004-02

Waterford 3's approach to achieving compliance with the requirements of GL 2004-02 consists of a combination of physical design changes, licensing basis changes, and administrative changes supported by conservative analytical and testing approaches. Taken together, these provide reasonable assurance that the Emergency Core Cooling System (ECCS) and Containment Spray System (CSS) recirculation functions of the SI Sump will be in compliance with the regulatory requirements of the GL once all actions are complete.

To support closure of GSI-191 and to address GL 2004-02, Waterford 3 has completed the following actions for Waterford 3. These actions are fully described in previous submittals [Refs. 3 and 4].

Completed Physical Design Changes

The following physical changes have been made that increase the debris handling capabilities of the SI Sump screens/strainers and to significantly reduce the predicted quantity of debris reaching the strainers:

- Replaced original strainers (~200 ft² surface area) with an engineered stacked disk strainer system that has a filtering surface area of 3699 ft²
- Fibrous insulation removal and replacement on the replacement steam generators with reflective metal insulation

Completed Analysis, Evaluations and Testing

- Latent debris sampling and characterization, including other debris sources, e.g., labels, etc.
- Generated and revised debris generation analysis based on walk down information
- Strainer head loss testing
- Fiber bypass testing
- Ex-vessel downstream effects analysis
- Net positive suction head analysis

Completed Licensing Basis Changes

Waterford 3 revised emergency operating procedures (OP-902-002, "Loss of Coolant Accident Recovery" and OP-902-008, "Functional Recovery") to provide contingency actions for a Low Pressure Safety Injection pump failing to trip on a Recirculation Actuation Signal when suction from the SI Sump begins.

Completed Administrative Changes

Enhancements and changes were made to several procedures to ensure that debris loading on the strainers will not be beyond the analyzed values. The procedures that were changed are as follows:

- EN-MA-118, "Foreign Material Exclusion"
- EN-DC-115, "Engineering Change Process"
- OP-902-002, "Loss of Coolant Accident Recovery"
- OP-902-008, "Functional Recovery"
- NOECP-318, "Control and Tracking of Containment Net Free Volume, Passive Heat Sink Volume and Surface Area and Aluminum and Zinc Inventory"

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 selection of closure option 2 to address GL 2004-02 for Waterford 3.

Analytical Conservatism in the Debris Generation Evaluations

The following debris generation analysis assumptions conservatively maximized the quantity of debris generated for any LOCA. This then maximizes the head losses across the strainer, thereby minimizing: NPSH available, structural and flow margins.

- All Nukon fiber debris generation is based on a 17D Zone of Influence (ZOI)
- Assumed that 10% of qualified coatings on the containment liner dome and the liner between elevations 112' and 138' will fail
- All un-qualified coatings fail as particulate and will transport to the strainers
- All coatings are at the maximum allowed thickness
- Metal Encapsulated Insulation manufactured by Transco is assumed to have a ZOI larger than the value of similarly constructed Transco Reflective Metal Insulation
- Latent debris loads are conservatively assumed to be 250 lbm. Latent debris survey performed in 2009 determined latent debris loads of 81 lbm

Analytical Conservatism in the Debris Transport Evaluations

The following debris transport analysis assumptions provided conservative values for transport of debris to the SI Sump.

- Maximum flow rates applied
- Transport based on velocity and Turbulent Kinetic Energy
- Debris hold-up not credited
- Debris settling not credited
- Fiber loading at time zero based on 30 day fiber erosion rates
- Lower containment flood water level used to maximize transport velocities
- Lift-over-curb velocity used was for a 6" high curb. Plenum on which the strainers sit is 8" high, plus the bottom disk for the strainers is approximately 3" above the plenum

Analytical Conservatism in the Net Positive Suction Head (NPSH) Determination Evaluations

The NPSH analyses maximized the debris loads and pump flow rates through the strainers, while minimizing the SI Sump water level available. These conservatisms ensure margin in all plant recirculation operations.

- No credit for Containment overpressure
- Debris head loss applied immediately

Analytical Conservatism in the Downstream Effects Evaluations

The following downstream effects evaluation assumptions maximize the potential for wear and/or blockage of equipment downstream of the strainers and employ the high pump flow rates of low head recirculation.

- Maximum flow rates employed
- 0% of fibers able to pass through the SI Sump Strainer are removed

Testing Approach Conservatism:

The head loss across the installed SI Sump strainer has been determined via testing using a “test for success” testing methodology in the areas of debris head loss testing and chemical effects testing conducted in accordance with the NRC’s March 2008 guidance document [Ref. 8].

Conservatism in the testing approach include:

- Strainer testing with fines
- Full WCAP-16530 chemicals
- Bounding flow rates
- Bounding extrapolations for head losses
- Full 30 day chemical precipitate load assumed to arrive at strainer at earliest possible time
- Metallic insulation debris excluded from tested debris bed
- Scaling calculations conservatively ignored bottom perforated surface of strainers
- No credit taken for silicon or phosphate inhibition of aluminum corrosion, even though Waterford 3 is a high fiber, Tri-Sodium Phosphate buffered plant

Overall Conclusion Regarding Conservatism

The aforementioned conservatism, in addition to the overall NEI methodology conservatism applied throughout the mechanistic analyses for the Generic Letter resolution and numerous conservatism not individually enumerated herein, will ensure successful ECCS pump operation at Waterford 3.

Summary of Margins and Conservatism for On-going Actions for GL 2004-02

The following provides a summary description of the margins and conservatism associated with the resolution actions that remain on-going. These margins and conservatism provide support for the selection of closure option 2 to address the in-vessel issues of GL 2004-02 for Waterford 3.

Conservatism considered for in-vessel

- ECCS Flow < bounding test value of 44.7 gpm/fuel assembly (FA)

WCAP-16793-NP [Ref. 5] results were reported at a high, bounding flow rate of 44.7 gpm/fuel assembly (which would correspond to approximately 9700 gpm total core flow at Waterford 3). These test results show that as the fuel assembly flow rate decreases the fiber limit can increase. In actuality, at Waterford 3, the maximum flow rates (considering Recirculation operation) prior to HLSO (simultaneous hot leg and cold leg injection) are on the order of 9.1 gpm/FA (which corresponds to approximately 1970 gpm total core flow and less than 21% of the test rate). Once on the long term HLSO alignment, the maximum flow rates through the core are no greater than 5.5 gpm/FA, which is less than 13% of the test rate.

Summary of Defense-In-Depth (DID) Measures

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

Strainer Blockage

Waterford 3 has within its' Emergency Operating Procedures (EOP) direction to monitor High Pressure Safety Injection (HPSI) pump flow, discharge pressure and motor amps to ensure that HPSI pump minimum flow requirements for pump protection are met; if monitored parameters are fluctuating, direction is provided to secure one HPSI pump.

Fuel (Core) Blockage

- Prevention

The Waterford 3 post LOCA SI Sump temperatures remain elevated (above the precipitation temperature for chemical effects) until after the transition to simultaneous hot leg and cold leg injection during recirculation. The SI Sump temperature will reach 210°F at about 2.2 hours after the Recirculation Actuation Signal. It will exceed 210°F for about 11 hours after the event. Per the Emergency Operating Procedures at Waterford 3, simultaneous hot leg and cold leg injection may start between 2 to 3 hours from the start of an event.

- Detection

Multiple methods exist for detection of a core blockage condition as manifested by an inadequate Reactor Coolant System (RCS) inventory and core heat removal condition. The primary methods include Core Exit Thermocouples (CET) and Reactor Vessel Level Instrumentation System (RVLIS). This monitoring is initiated early in the event in the EOPs through the Safety Function Status Checklist which is monitored continuously by shift crew personnel with data verified every 30 minutes by the Shift Technical Advisor.

- Mitigation

Upon identification of an inadequate RCS inventory or core heat removal condition, the EOPs direct the operators to take actions to restore cooling flow to the RCS including:

- Establish Safety Injection flow to RCS.
- Refill the Refueling Water Storage Pool (RWSP).
- Perform a plant cooldown to allow depressurizing the RCS.
- Opening RCS vents to the Quench Tank if voiding is impeding natural circulation.
- Establish charging flow.

The operators will also inform the Technical Support Center (TSC) of the condition. The TSC will evaluate the condition and recommend the following actions, as necessary, to the operators to restore core heat removal:

- Makeup to the RWSP from various plant water sources. These water sources include the following borated water source, Chemical and Volume Control system and non-borated water sources: Fire Water Storage Tank(s) and Condensate Storage Pool.
- Flood containment using fire hydrants and portable pump.

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 ECC and CS 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 selection of closure option 2 to completely address GL 2004-02 for Waterford 3.

Conclusion

The GSI-191 resolution path for Waterford 3 is acceptable, based on the information provided in this document. The execution of the actions identified in this document will result in successful resolution of GSI-191 and closure of GL 2004-02.

References

- 1) NRC SECY-12-0093, "Closure Options for Generic Safety Issue - 191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance" dated July 9, 2012.
- 2) SRM-NRC SECY-12-0093, "Closure Options for Generic Safety Issue - 191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance" dated December 14, 2012.
- 3) Waterford 3 letter W3F1-2008-0069, 10/23/08, "Final Supplemental Response to NRC Generic Letter 2004-02," "Potential Impact Of Debris Blockage On Emergency Recirculation During Design Basis Accidents At Pressurized-Water Reactors."
- 4) Waterford 3 letter W3F1-2010-0032, 11/23/2010, "Response to Request for Additional Information Regarding Final Supplemental Response to Generic Letter 2004-02, Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors."
- 5) WCAP-16793-NP, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid," Revision 2, October 2011.
- 6) Waterford 3 Letter W3F1-2003-0050, 8/7/2003, "60-Day Response to NRC Bulletin 2003-01, Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors."

- 7) Waterford 3 Letter W3F1-2004-0100, 10/27/2004, "Response to Request for Additional Information Regarding Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors."
- 8) NRC letter to NEI, "Revised Guidance for Review of Final Licensee Responses to Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," dated March 28, 2008.

Attachment 2

W3F1-2013-0027

List of Regulatory Commitments

List of Regulatory Commitments

The following table identifies those actions committed to by Waterford 3 in this document. Any other statements in this submittal are provided for information purposes and are not considered to be regulatory commitments.

COMMITMENT	TYPE (Check One)		SCHEDULED COMPLETION DATE (If Required)
	ONE- TIME ACTION	CONTINUING COMPLIANCE	
Investigation of insulation for possible future replacement will be performed before and during the next refueling outage for Waterford 3 which is currently scheduled for the Spring of 2014.	x		Spring of 2014
In the event that the PWROG testing program for increasing the allowable amount of fiber per fuel assembly is not successful in increasing this limit above the plant specific values for Waterford 3, any necessary replacement or remediation of insulation will be completed by the third refueling outage following January 1, 2013 (tentatively scheduled for Spring 2017).	x		Spring 2017
Within six months of establishing a final determination of the scope of insulation replacement, remediation, or model refinements, Waterford 3 will submit a final updated supplemental response to support closure of GL 2004-02 for Waterford 3. Based on the PWROG Program Schedule, Waterford 3 expects to submit the final updated response by June 30, 2015.	x		June 30, 2015
Waterford 3 will evaluate the current licensing basis within three months following NRC acceptance of the final updated supplemental response for Waterford 3.	x		Within three months of NRC acceptance of final updated supplemental response for Waterford 3.
If Waterford 3 removes or modifies insulation debris sources in			Within six months after refueling

containment, then Waterford 3 will revise its' current license bases within six months after any refueling outage where insulation change occurs.			outage when insulation change occurs.
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