ENCLOSURE 3

License Amendment Request for STP Piloted Risk-Informed Approach to Closure for GSI-191

Changes to Enclosure 3:

1. Editorial wording changes in the Summary Description with respect to use of the PRA.
2. Deleted estimated quantification of safety improvement from new strainer design in discussion of new strainers. Enclosures 2 and 3 adequately address risk quantification.
3. Revised references to Enclosure 4-3 to match revised section numbering in Enclosure 4-3 (various places).
4. Deleted paragraph at end of Section 3.3.1 detailing original CDF and LERF numbers since the information is presented in Section 4 of Enclosure 4-2.
5. Changed title of Section 3.3.3 to "Description of the PRA" and deleted Sections 3.3.4 – 3.3.6 of the PRA description and referenced the same information presented in Enclosure 4-1. Renumbered following sections as necessary.
6. Deleted debris description details repeated from Enclosure 4-3 from the operability determination process discussion in Section 4.1.3. The section appropriately references Enclosure 4-3.
7. Clarified that 10CFR50.59 will be the change control process for the UFSAR sections that implement the proposed license amendment.
8. Revised UFSAR markups to reflect new revision to Enclosure 4-3. Parameter for Aluminum removed from Table in proposed App. 6A.

License Amendment Request for STP Piloted Risk-Informed Approach to Closure for GSI-191

1. Summary Description

Pursuant to 10 CFR 50.90, STP Nuclear Operating Company (STPNOC) requests to amend Operating Licenses NPF-79 and NPF-80 for South Texas Project (STP) Units 1 and 2. The proposed amendment will revise the South Texas Project Electric Generating Station (STPEGS) Updated Final Safety Analysis Report (UFSAR) using a risk-informed approach to address safety issues discussed in Generic Safety Issue (GSI) -191, "Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance" (Reference 1).

GSI-191 concerns include the effects on long-term cooling due to debris accumulation on Emergency Core Cooling System (ECCS) and Containment Spray System (CSS) sump strainers in recirculation mode, as well as core flow blockage due to in-vessel effects (including boric acid precipitation), following loss of coolant accidents (LOCAs). Since sump performance and in-vessel effects are important considerations in the safety analysis and are not explicitly described in the STP current licensing basis, the proposed amendment incorporates a risk-informed method used to demonstrate that sump performance and in-vessel effects are acceptable so that the current licensing basis safety analysis conclusions remain valid.

The risk-informed approach is consistent with the guidance of NRC Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis" (Reference 2).

The proposed change is to use a Probabilistic Risk Assessment (PRA) model that incorporates the risks related to GSI-191 by including detailed containment emergency sump performance in the PRA. The analysis covers a full spectrum of postulated LOCAs, including double-ended guillotine breaks (DEGBs), for all pipe sizes up to and including the design basis accident (DBA) LOCA, to provide assurance that the most severe postulated loss-of-coolant accidents are evaluated. The evaluation includes single failure criteria as well as multiple failures of systems and equipment including the probability for loss of all function in one or more trains. Success criteria are based on maintaining available net positive suction head (NPSH) and strainer structural integrity in support of ECCS and CSS operation in recirculation mode following postulated LOCAs and adequate in-vessel core flow, considering the debris loading associated with GSI-191 concerns. The risk-informed method is used to generate risk metrics for GSI-191 for comparison to the acceptance guidelines in RG 1.174.

The proposed change to the UFSAR implements a risk-informed rather than a deterministic method to demonstrate compliance. STPNOC is also requesting exemptions from certain regulatory requirements as provided in Enclosures 2-1 through 2-4 to this letter. Approval of the proposed amendment is contingent on approval of the exemption requests.

2. Detailed Description

The proposed amendment will add Appendix 6A, "Risk-Informed Approach to Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents," to the STP UFSAR. This appendix describes the evaluations performed using a risk-informed approach to address GSI-191 concerns including the effects on long-term cooling due to debris accumulation on containment sump strainers for ECCS and CSS in recirculation mode, as well as core flow blockage due to in-vessel effects, following loss of coolant accidents (LOCAs).

Modifications Previously Implemented to Address GSI-191

Appendix 6A discusses the ECCS sump performance evaluations performed to address GSI-191. These evaluations account for previously implemented hardware modifications and plant procedures and processes to provide high confidence that the sump design supports long-term core cooling following a design basis loss of coolant accident (LOCA). Those design modifications and procedure changes were implemented in accordance with 10 CFR 50.59 and are not part of this license amendment request.

Installation of New Sump Strainer Assemblies

To address concerns associated with GSI-191, new ECCS containment sump strainer assemblies were installed in STP Unit 1 in October 2006 and in STP Unit 2 in April 2007. The strainer upgrade was achieved at a cost on the order of $6.3M. The surface area of the strainers was increased from approximately 155 square feet per sump to approximately 1818 square feet per sump. The screen-hole size of the strainers was reduced from 0.25 inches diameter to 0.095 inches diameter. Small particles in water entering the suction pipe from the sump cannot clog the containment spray nozzles (3/8-inch orifice diameter). Installation of the new strainers did not affect the independence and redundancy of the sumps.

The sump strainer design implemented by these modifications meets the current design basis requirements with respect to net positive suction head (NPSH) and ECCS performance. The sumps are designed according to RG 1.82 proposed Revision 1, dated May 1983 (Reference 3), which recommends a calculation of sump screen head loss due to debris blockage. Utilizing the current licensing basis methodology (Reference 3), the pump NPSH is sufficient to accommodate this head loss. The STP sumps meet the function to preclude passage of debris particles large enough to damage downstream components in the ECCS and CSS. Detailed evaluations and descriptions of the design are provided in References 4 and 5. The sump strainer design has been evaluated to meet the current design basis assumptions for analyzing the effects of post-accident debris blockage and for compliance with 10 CFR 50.46 for long term cooling, General Design Criterion (GDC) 35 for emergency core cooling, GDC 36 for inspection of ECCS, GDC 38 for containment heat removal, GDC 39 for inspection of containment heat removal system, and GDC 41 for containment atmosphere cleanup (References 4, 5 and 6).

The new strainer design is a safety improvement that contributed to the desired shift from RG 1.174 Region II, "Small Changes," to Region III, "Very Small Changes," for the results from the risk-informed method discussed in the next section.

The current licensing basis for the sumps is based on a deterministic methodology that was used to analyze susceptibility of the ECCS and CSS recirculation functions for adverse effects of post-accident debris (Reference 7). The methodology was largely in accordance with Nuclear Energy Institute report NEI 04-07 (Reference 8) and the associated NRC Safety Evaluation Report (SER) (Reference 9). In addition, evaluations were performed in accordance with WCAP-16406-P-A, "Evaluation of Downstream Sump Debris Effects in Support of GSI- 191," Revision 1 (Reference 10) and WCAP-16793-NP," Evaluation of Long-Term Cooling Considering Particulate and Chemical Debris in the Recirculating Fluid" (Reference 11) to consider the effects that debris carried downstream of the containment sump screen and into the reactor vessel has on core cooling, including fuel and vessel blockage. STPNOC also evaluated the type and expected quantity of chemical products that would be expected to form in the recirculation fluid specifically for STP using the methodology developed in WCAP-16530-NP, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191," (Reference 16). To support the sump performance evaluation, STPNOC performed containment walkdowns using the guidance of NEI 02-01 (Reference 12).

However, these deterministic evaluations have not been shown to demonstrate that the new strainer design fully resolves GSI-191 concerns for the as-built, as-operated plant.

Following installation of the new sump strainers, protective gratings were installed in front of the strainers to preclude inadvertent damage to these components. The framing structure for the protective gratings consists of vertical grating panels attached to metal columns that are welded to base plates that are anchored into the concrete floor, and is qualified for Seismic II/I loading to ensure the maximum stresses are below the allowable limits. The structure is made of carbon steel and has a qualified coating applied.

Replacement of Fibrous Insulation

Per the original plant design, the reactor vessel nozzles were insulated with a non-crush insulation material composed of calcium silicate (brand name Marinite). Based on concerns related to the potential for calcium silicate to combine with the tri-sodium phosphate (TSP) pH buffer during post-LOCA conditions to form calcium phosphate precipitates which could block the strainers, the adequacy of the design and validation testing of the emergency sump strainers was questioned. Marinite insulation was identified as a significant contributor to the debris loading associated with one of the worst case LOCA scenarios for strainer head loss based on previous evaluations. As a result, all of the Marinite insulation was replaced with NUKON fiberglass insulation. These modifications were accomplished during the Fall 2009 refueling outage for STP Unit 1 and the Spring 2010 refueling outage for Unit 2.

Additional replacement of the fibrous insulation in containment required to fully resolve GSI-191 based on the deterministic evaluations was estimated to cost approximately $55M with a dose estimate of approximately 88 Rem per unit. Enclosure 2 to this letter provides details and discussion on the estimated dose considerations for these insulation modifications. Given the very low risk associated with the impact of this insulation on sump performance, STPNOC decided to pursue a risk-informed resolution to GSI-191 rather than incur the economic and radiological costs associated with replacement of the fibrous insulation.

<u>Use of a Risk-Informed Approach to Resolving GSI-191</u>

The risk associated with GSI-191 issues has been quantified and is less than the threshold for "Very Small Changes" in Region III as defined in RG 1.174. The proposed UFSAR Appendix 6A describes the risk-informed approach used to confirm that the ECCS and CSS will operate with a high probability following a LOCA when considering the impacts and effects described by GSI-191. Therefore no further physical modifications to STP Units 1 and 2 are proposed as part of this license amendment request to implement the risk-informed approach.

Attachment 1 to this Enclosure provides the Licensee Commitment to implement the proposed amendment following approval and to revise affected sections of the UFSAR as indicated by the proposed changes in Attachment 2 to this Enclosure. Upon approval of the proposed amendment, applicable UFSAR safety system and design bases descriptions that take credit for the evaluation described in Appendix 6A will be revised. In addition, conforming changes to the Technical Specification (TS) Bases are provided in Attachment 3 to this Enclosure for information only, to be implemented following NRC approval of the LAR.

The design and licensing basis descriptions of accidents requiring ECCS operation, including analysis methods, assumptions, and results provided in UFSAR Chapters 6 and 15 remain unchanged. This is based on the functionality of the ECCS and CSS during design basis accidents being confirmed by demonstrating that the calculated risk associated with GSI-191 for STP Units 1 and 2 is "Very Small" and less than the Region III acceptance guidelines defined by RG 1.174.

The performance evaluations for accidents requiring ECCS operation described in Chapters 6 and 15, based on the South Texas Project Units 1 and 2 Appendix K Large-Break Loss-of-Coolant Accident (LBLOCA) analysis, demonstrate that for breaks up to and including the double-ended guillotine break of a reactor coolant pipe, the ECCS will limit the clad temperature to below the limit specified in § 50.46, and assure that the core will remain in place and substantially intact with its essential heat transfer geometry preserved.

The proposed amendment does not require a change to the STP TS. The basis for this conclusion is found in the Regulatory Evaluation Section of this LAR. Specific values and limits contained in the TS and the response times for the safety system assumed in the accident analyses are not changed.

System redundancy, independence, and diversity features are not changed for those safety systems credited in the accident analyses. No new programmatic compensatory activities or reliance on manual operator actions is required to implement this change.

3.0 Technical Evaluation

3.1 Current System Descriptions

Emergency Core Cooling System

The Emergency Core Cooling System (ECCS) is designed to cool the reactor core and provide shutdown capability subsequent to the following accident conditions:

1. Pipe breaks in the Reactor Coolant System (RCS) which cause a discharge larger than that which can be made up by the normal makeup system, up to and including the instantaneous circumferential rupture of the largest pipe in the RCS.

2. Rupture of a control rod drive mechanism (CRDM) causing a rod cluster control assembly (RCCA) ejection accident.

3. Pipe breaks in the steam system, up to and including the instantaneous circumferential rupture of the largest pipe in the steam system.

4. A steam generator tube rupture.

The primary function of the ECCS is to remove the stored and fission product decay heat from the reactor core and to provide shutdown capability during accident conditions.

The ECCS provides shutdown capability for the accidents above by means of boron injection. It is designed to tolerate a single active failure in the short term or a single active or passive failure in the long term. The system meets its minimum required performance level with onsite or offsite electrical power.

The ECCS consists of the high head safety injection (HHSI) and low head safety injection (LHSI) pumps, Safety Injection System (SIS) accumulators, residual heat removal (RHR) heat exchangers (HXs), the refueling water storage tank (RWST) along with the associated piping, valves, instrumentation, and other related equipment.

The design bases for selecting the functional requirements of the ECCS, such as peak fuel cladding temperature, etc., are derived from Appendix K limits as delineated in 10CFR50.46. The subsystem functional parameters are integrated so that the Appendix K requirements are met over the range of anticipated accidents and single failure assumptions.

Reliability of the ECCS has been considered in selection of the functional requirements, selections of the particular components, and location of components and connected piping. Redundant components are provided where the loss of one component would impair reliability. Valves are provided in series where isolation is desired. Redundant sources of the ECCS actuation signal are available so that the proper and timely operation of the ECCS is not inhibited. Sufficient instrumentation is available so that a failure of an instrument does not impair readiness of the system. The active components of the ECCS are powered from separate buses which are energized from offsite power supplies.

In addition, the standby diesel generators assure that adequate redundant sources of auxiliary onsite power are available to meet all ECCS power requirements. Each diesel is capable of driving all pumps, valves, and necessary instruments associated with one train of the ECCS.

The elevated temperature of the sump solution during recirculation is well within the design temperature of all ECCS components. In addition, consideration has been given to the potential for corrosion of various types of metals exposed to the fluid conditions prevalent immediately after the accident or during long-term recirculation operations.

10 CFR 50.46(b) provides the following criteria to judge the adequacy of the ECCS.

1. Peak clad temperature calculated shall not exceed 2,200°F.

2. The calculated total oxidation of the clad shall nowhere exceed 0.17 times the total clad thickness before oxidation.

3. The calculated total amount of hydrogen generated from the chemical reaction of the clad with water or steam shall not exceed 0.01 times the hypothetical amount that would be generated if all of the metal in the clad cylinders surrounding the fuel, excluding the clad around the plenum volume, were to react.

4. Calculated changes in core geometry shall be such that the core remains amenable to cooling.

5. After any calculated successful initial operation of the ECCS, the calculated core temperature shall be maintained at an acceptably low value and decay heat shall be removed for the extended period of time required by long-lived radioactivity remaining in the core.

<u>Containment Heat Removal System (CHRS)</u>

The CHRS consist of the Reactor Containment Fan Cooler (RCFC) Subsystem, which is a part of the Reactor Containment HVAC System, and the Containment Spray System (CSS). The ECCS assists the CHRS by transferring heat from the reactor core to the Containment sump. The Residual Heat Removal (RHR) heat exchangers, in conjunction with the ECCS low-head Safety Injection (SI) pumps, are used to transfer heat from the Containment sumps to the Component Cooling Water System (CCWS). The RCFCs are also cooled by the CCWS following an SI signal. The CCWS rejects this heat to the ultimate heat sink via the Essential Cooling Water System (ECWS).

The CSS transfers heat from the Containment atmosphere to the Containment sump; it also removes iodine from the Containment atmosphere.

The CHRS meets the following design bases:

1. The CHRS is capable of removing sufficient energy to limit the peak Containment pressure and to limit the Containment pressure to a low value at the end of 24 hours after a DBA.

2. In order to ensure the satisfactory operation of the systems after a DBA, each active component is testable during reactor power operation.

3. The system is divided into three trains, with each train receiving power from a separate Emergency Safety Features (ESF) power supply.

The CSS is:

1. Designed such that it will tolerate a single active failure.

2. Designed to accommodate the operating basis earthquake (OBE) within stress limits of applicable codes and to withstand the safe shutdown earthquake (SSE) without loss of function.

3. Designed to assist in reducing offsite exposures resulting from a design basis accident (DBA) to less than the limits of 10 CFR 100 by rapidly reducing the airborne elemental iodine and particulate concentrations in the Containment following a DBA.

<u>Containment Emergency Sump</u>

The Containment emergency sump meets the following design bases:

1. Sufficient capacity and redundancy to satisfy the single-failure criteria. To achieve this, each CSS/ECCS train draws water from a separate Containment emergency sump.

2. Capable of satisfying the flow and net positive suction head (NPSH) requirements of the ECCS and the CSS under the most adverse combination of credible occurrences. This includes minimizing the possibility of vortexing in the sump.

3. Minimizes entry of high-density particles (specific gravity of 1.05 or more) or floating debris into the sump and recirculating lines.

4. Sumps are designed in accordance with RG 1.82, proposed revision 1, May 1983.

Three independent sumps serve as reservoirs to the ECCS and CSS pumps during the recirculation phase post-DBA. Each sump is stainless steel lined, contains a Vortex Suppressor, and is provided with four stainless steel strainer assemblies. The strainer assemblies for each sump consist of two 5-module assemblies, one 4-module assembly, and one 6-module assembly with each module made up of eleven strainer discs. The strainer screen consists of perforated plate with nominal 0.095 inch diameter openings. Flow leaving the strainer enters a four inlet plenum box (one inlet for each strainer assembly). The plenum box collects the flow from the strainer assemblies and directs the flow vertically downward directly into the sump pit. An access cover is provided on the plenum box for internal inspections of the sump structures, vortex suppressor, and the strainer assemblies.

The sumps are located at the -11 feet-3 inch level of Reactor Containment Building (RCB). The sumps are physically separated from each other with no high-energy piping in the area. The floor around the emergency sumps slopes away from them and toward normal sumps located in the area. The drains from the upper levels of the RCB do not terminate in the immediate area of the sumps.

The sump structures are designed to withstand the SSE without loss of structural integrity. Water entering the suction pipe from the sump may contain a small amount of particulate and fibrous debris (less than 0.095-inch in diameter). This debris cannot clog the spray nozzles (3/8-in. orifice diameter) which are the limiting restrictions in the CSS system served by the sump.

At the beginning of the recirculation phase, the minimum water level above the RCB floor is adequate to provide the required NPSH for the ECCS and CSS pumps.

The sumps are designed to NRC RG 1.82, proposed revision 1, May 1983. The sump structures are designed to limit approach flow velocities to less than 0.009 feet/second permitting high-density particles to settle out on the floor and minimize the possibility of clogging the strainers. The sump structures are designed to withstand the maximum expected differential pressure imposed by the accumulation of debris.

Most potential sources of debris are remote from the emergency sumps and are separated by shield walls or other partitions. Expected debris is pieces of insulation and paint. The possibility of paint chips peeling off has been reduced by requiring proper surface preparation and by painting large surface components (such as: the Containment liner, RCS supports, floors, and structural steel) with coatings which have been qualified under DBA conditions.

The major insulation types used in the RCB are stainless steel reflective, blanket fiberglass, and cellular glass. The stainless steel reflective insulation is used on the major NSSS components. The blanket fiberglass type is used on the hot piping and equipment. Cellular glass insulation is used on cold piping for antisweat purposes. Microtherm is also used for piping in the wall penetrations.

Containment emergency sumps are inspected periodically as delineated in the Technical Specifications, as described in Section 4.1.3 below.

The current design for the containment sumps and strainers was assessed in response to NRC Generic Letter 2004-02 (Reference 7), and STPNOC provided specific information regarding the deterministic methodology for demonstrating compliance, applying industry and NRC guidance. However, since this methodology has not been demonstrated to fully resolve GSI-191 without the need for additional changes to the plant design, such as extensive modifications to insulation in the containment, a risk-informed approach is applied to evaluate acceptable sump design using the guidance in RG 1.174.

3.2 Background

GSI-191 concerns the possibility that debris generated during a LOCA could clog the containment sump strainers in pressurized-water reactors (PWRs) and result in loss of net positive suction head (NPSH) for the ECCS and CSS pumps, impeding the flow of water from the sump. GL 2004-02 requested licensees to address GSI-191 issues, focused on demonstrating compliance with the ECCS acceptance criteria in § 50.46. GL 2004-02 requested licensees to perform new, more realistic analyses using an NRC-approved methodology and to confirm the functionality of the ECCS and CSS during design basis accidents that require containment sump recirculation.

The STP piloted risk-informed approach maintains the defense-in-depth measures in place to mitigate the residual risk of strainer or in-vessel issues to provide closure for GSI-191. These measures include those implemented in response to NRC Bulletin 2003-01 and GL 2004-02 to address the potential for sump strainer clogging and other concerns associated with GSI-191. Additional measures such as operating procedures and instrumentation to monitor core level and temperature, and actions taken by operators if core blockage is indicated, have been implemented. These actions have been implemented pursuant to 10 CFR 50.59 and are not the subject of this license amendment request. Detailed discussion regarding defense-in-depth is provided in Enclosure 4-1 (Section 2 and Appendix C) to this letter. These measures are part of the defense-in-depth for STP and remain in place.

In addition, larger containment sump strainers have been installed that greatly reduce the potential for loss of net positive suction head (NPSH).

The Commission issued Staff Requirements Memorandum (SRM)-SECY-10-0113, "Closure Options for Generic Safety Issue (GSI) - 191, Assessment of Debris Accumulation on Pressurized Water Reactor (PWR) Sump Performance," directing the staff to consider alternative options for resolving GSI-191 that are innovative and creative, as well as risk-informed and safety conscious. Subsequently, STPNOC, through interactions with the staff, developed a risk-informed approach for the resolution of GSI-191 based on the guidance in RG 1.174. By Reference 13, STPNOC submitted to the NRC the preliminary results showing that the risks, Core Damage Frequency (CDF) and Large Early Release Frequency (LERF), associated with GSI-191 concerns are less than the threshold for Region III, "Very Small Changes," of RG 1.174, and notified the NRC of the intent to seek exemption from certain requirements of § 50.46. SECY-12-0093, "Closure Options for Generic Safety Issue - 191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance," described the staff plans to use STPNOC as a pilot for other licensees choosing to use this approach (Reference 14). The exemption request from certain requirements of § 50.46 including impacted General Design Criteria of Appendix A of Part 50 is provided in Enclosure 2 to this letter.

3.3 Evaluation

3.3.1 Engineering Analysis Overview

The design and licensing basis descriptions of accidents requiring ECCS and CSS operation, including analysis methods, assumptions, and results provided in UFSAR Chapters 6 and 15 remain unchanged. This is based on the functionality of the ECCS and CSS during design basis accidents being confirmed by demonstrating that the calculated risk associated with GSI-191 for STP Units 1 and 2 is "Very Small" and less than the Region III acceptance guidelines defined by RG 1.174.

The performance evaluations for accidents requiring ECCS operation described in Chapters 6 and 15, based on the South Texas Project Units 1 and 2 Appendix K Large-Break Loss-of-Coolant Accident (LBLOCA) analysis, demonstrate that for breaks up to and including the double-ended guillotine break of a reactor coolant pipe, the ECCS will limit the clad temperature to below the limit specified in § 50.46, and assure that the core will remain in place and substantially intact with its essential heat transfer geometry preserved.

The plant-specific Probabilistic Risk Assessment (PRA) model was used to calculate the difference in risk (delta risk) between the actual plant configuration subject to the concerns raised by GSI-191 and a hypothetical plant configuration not subject to GSI-191, but otherwise identical. The difference in risk is a quantification of the risk associated with GSI-191 concerns. This risk includes the effects on long-term cooling due to debris accumulation on the ECCS and CSS containment sump strainers and the in-vessel effects following LOCAs that require recirculation flow from the containment sump to mitigate the event. The quantification of the risk associated with GSI-191 concerns conservatively defines the change to be evaluated, as discussed in RG 1.174,

The methodology for calculating the risk associated with GSI-191 concerns using the probabilistic risk assessment (PRA) model considered a full spectrum of postulated LOCAs, including double-ended guillotine breaks (DEGBs), for all pipe sizes up to and including the design basis accident (DBA) LOCA. The physical processes are modeled as realistically as possible, using results from industry and plant-specific testing, and applying conservatism, where appropriate. The risk due to GSI-191 concerns is then shown to meet RG 1.174 acceptance guidelines for changes to Core Damage Frequency (CDF) and Large Early Release Frequency (LERF).

RG 1.200 Revision 2 provides new guidance for certain external events but contains the same guidance as RG 1.200 Revision 1 for internal events. STPNOC's PRA is compliant with RG 1.200 Revision 1 for internal events, and therefore is compliant with RG 1.200 Revision 2 for assessing the risk of internal events associated with GSI-191. For purposes of GSI-191, only internal events are of concern because GSI-191 involves LOCAs. Enclosure 4-2 to this letter describes the STP PRA model used for the risk-informed approach and provides additional justifications for the applicability of the STP PRA model to this approach.

Using a risk-informed approach to address the concerns of GSI-191, the probability that the long-term cooling criterion would not be exceeded for the calculated ECCS cooling performance is quantified. The method of analysis for the risk-informed approach uses an integrative approach to explicitly provide the probabilities for post-LOCA events. This is accomplished by modeling the underlying physical phenomena of the basic events and by propagating uncertainties in the physical models.

To determine the risk associated with GSI-191 concerns, under the framework of RG 1.174, the STP piloted risk-informed approach to closure for GSI-191 applies the plant-specific PRA model to calculate the difference in risk (delta risk) for two cases:

- <u>Case 1</u>: the actual plant configuration, risk informed to model the failure mechanism associated with the concerns raised by GSI-191, and
- <u>Case 2</u>: a hypothetical plant assuming no failure mechanisms associated with the concerns raised by GSI-191, otherwise identical to the actual plant.

The risk associated with GSI-191 concerns is the difference in risk (CDF and LERF) between Case 1 and Case 2 for comparison with the acceptance guidelines in RG 1.174, Section 2.4.

The inputs to the risk model encompass the concerns raised in GSI-191, including the major topical areas discussed in NEI 04-07 (Reference 8), as appropriate:

- pipe break characterization
- debris generation/zone of influence (ZOI), including latent debris
- debris transport
- chemical effects
- strainer head loss, including structural margin
- air intrusion
- debris penetration
- ex-vessel downstream effects
- in-vessel downstream effects
- boron precipitation

For each input to the risk model, any differences between the methods to be used in the model and NRC-approved methods (e.g. Reference 9) are defined. To apply the inputs, the demand recirculation failure probability in the plant-specific PRA model is replaced with the following basic events:

- Pressure drop due to debris build-up on the sump strainers with chemical effects resulting in loss of net positive suction head (NPSH) margin for pumps.
- Strainer mechanical collapse, where P-buckle is the strainer structural design limit for the differential pressure (DP) across the ECCS strainers at which they are analyzed to be within code design allowable stresses.
- Air ingestion through the sump strainers, where F-void is the vapor fraction of the liquid just downstream of the ECCS strainers.
- Core blockage with chemical effects.
- Boron precipitation in the core.

Failure modes leading to core damage are explicitly modeled, excluding those that were previously addressed for the plant using deterministic evaluations.

Failure probabilities and associated uncertainties determined in the supporting engineering analysis provided inputs to the three new top events added to the PRA to accommodate composite GSI-191 failure processes, and the outcome of a full spectrum of LOCA events was tested against appropriate performance thresholds for the top events, as shown below. The bases for these limits are described in Enclosure 4-1 and Enclosure 4-3.

New Top Events	Performance Thresholds
1. Failure at sump strainers	1. Strainer DP ≥ NPSH margin 2. Strainer DP ≥ P-buckle 3. Strainer F-void ≥ 0.02
2. Boron precipitation in the core	4. Core fiber load ≥ cold leg break fiber limit for boron precipitation 5. Core fiber load ≥ hot leg break fiber limit for boron precipitation
3. Core flow blockage	6. Core fiber load ≥ cold leg break fiber limit for flow blockage 7. Core fiber load ≥ hot leg break fiber limit for flow blockage

The results of the risk-informed approach are as follows (from Enclosure 4-2, Volume 2 Section 4):

- Change in CDF is ~ 2.88E-8/yr
- Change in LERF is ~ 1.40E-11/yr

The results demonstrate that the calculated risk associated with GSI-191 concerns for STP Units 1 and 2 are very small and are less than the threshold for Region III in RG 1.174. The functionality of the ECCS and CSS during design basis accidents is confirmed.

3.3.2 Evaluation of Defense-in Depth and Safety Margin

Defense-in-Depth (DID) Analysis

The proposed change is consistent with the DID philosophy in that the following aspects of the facility design and operation are unaffected:

- Functional requirements and the design configuration of systems
- Existing plant barriers to the release of fission products
- Design provisions for redundancy, diversity, and independence
- Plant's response to transients or other initiating events
- Preventive and mitigative capabilities of plant design features

The proposed amendment does not involve a change in any functional requirements or the configuration of plant structures, systems and components (SSCs).

The proposed amendment uses a risk-informed approach that analyzes a full spectrum of LOCAs, including double-ended guillotine breaks for all piping sizes up to and including the largest pipe in the reactor coolant system (RCS). By requiring that mitigative capability be maintained in a realistic and risk-informed evaluation of GSI-191 for a full spectrum of LOCAs, the approach ensures that defense-in-depth is maintained.

Appendix C of Enclosure 4-1 provides a more detailed description of the defense-in-depth measures that address potential sump blockage and in-core effects, including the means available to operators for detecting and mitigating inadequate recirculation flow and inadequate core cooling flow. The proposed change does not involve a change in any functional requirements, the configuration, or method of performing functions of plant SSCs. The effects from a full spectrum of LOCAs, including double-ended guillotine breaks for all piping sizes up to and including the largest pipe in the reactor coolant system, are analyzed. Appropriate redundancy and consideration of loss of offsite power and worst case single failure are retained. This approach ensures that DID is maintained.

The analysis shows that DID is maintained. The SSCs supporting DID are unchanged. The analysis shows there is no appreciable risk to containment integrity associated with the concerns raised in GSI-191. The as-built, as-operated containment design remains adequate to prevent a significant release into the environment. In quantification of the risk, no credit is taken for additional operator actions or programmatic activities beyond the existing as-built, as-operated plant.

Safety Margin Analysis

Approval of the proposed change would add the results of a risk-informed evaluation to the UFSAR that concludes the containment sumps will operate with a high probability in support of ECCS and CSS recirculation modes following a LOCA when considering the impacts and effects of debris on sump strainers, as well as core flow blockage due to in-vessel effects.

The proposed change does not involve a change in any functional requirements, the configuration, or method of performing functions of plant SSCs. The effects from a full spectrum of LOCAs, including double-ended guillotine breaks for all piping sizes up to and including the largest pipe in the reactor coolant system, are analyzed.

The proposed change does not result in any changes to the safety analyses demonstrating safety margin for the barriers to the release of radioactivity as described in the UFSAR. Appendix C of Enclosure 4-1 provides a more detailed discussion on how sufficient safety margins associated with the design are maintained by the proposed change.

3.3.3 Description of the PRA

The STPNOC PRA is a full-scope integrated Level I and Level II PRA that includes internal and external events with the focus of the GSI-191 concerns related to LOCA. The STPNOC PRA and the engineering analysis supporting the GSI-191 analysis are representative of the as-built, as-operated plant. The STPNOC PRA is reviewed for compliance/ adherence with the plant design and plant data review every 36 months as a UFSAR Chapter 13.7 commitment required for PRA applications.

The PRA is not significantly changed to specifically address the GSI-191 concerns. Instead, a detailed engineering analysis is performed in an uncertainty quantification framework that evaluates the required failure modes of ECCS and core cooling (in-vessel effects).

Significant detail is included in the engineering analysis used to develop the required new basic events and top events. Details include physical models and mechanisms known to lead to failure, and the analyses account for experimental evidence used to support particular areas of concern.

RG 1.200 Revision 2 provides new guidance for certain external events. STPNOC's PRA is compliant with RG 1.200, Revision 1 for internal events, and therefore is compliant with Regulatory Guide 1.200, Revision 2 for assessing the risk of internal events associated with GSI-191. The methodologies, applications, and results derived from the STPNOC PRA are reviewed by peers in benchmarking and other activities and are also regularly published in the open literature and symposia.

Enclosure 4-1 to this letter provides a more detailed description of the PRA.

3.3.4 Implementation and Monitoring Program

Design modifications addressing GSI-191 concerns, including installation of new sump strainers and replacement of problematic insulation, have been previously implemented using the STP design change process.

STPNOC has implemented procedures and programs for monitoring, controlling and assessing changes to the plant that have a potential impact on plant performance related to GSI-191 concerns. These provide the capability to monitor the performance of the sump strainers and the ability to assess impacts to the inputs and assumptions used in the PRA and the associated engineering analysis that support the proposed change. Programmatic requirements ensure that the potential for debris loading on the sump does not materially increase. These include:

- <u>Programs and procedures have been implemented to evaluate and control potential sources of debris in containment</u>:
  - Technical Specification Surveillance Requirements implemented by STP procedures require visual inspections of all accessible areas of the containment to check for loose debris, and each containment sump to check for debris, as described in Section 4.1.3.
  - The STP Design Change Package procedure includes provisions for managing potential debris sources such as insulation, qualified coatings, addition of aluminum or zinc, and potential effects of post-LOCA debris on recirculation flow paths and downstream components. The procedure has been augmented to explicitly require changes that involve any work or activity inside the containment be evaluated for the potential to affect the following:
    - Reactor coolant pressure boundary integrity
    - Accident or post-accident equipment inside containment
    - Quantity of metal inside containment

    - Quantity or type of coatings inside containment
    - Thermal insulation changed or added
    - Post-LOCA recirculation flow paths to the emergency sumps
    - Post-LOCA recirculation debris impact on internals of fluid components
    - Addition or deletion of cable

  A 10 CFR 50.59 screening or evaluation is required to be completed for all design changes. This process ensures that new insulation material that may differ from the initial design is evaluated for GSI-191 concerns.

  - Programs to ensure that Service Level 1 protective coatings used inside containment are procured, applied, and maintained in compliance with applicable regulatory requirements. Additional details are discussed in the STP response to Generic Letter 98-04 (Reference 15). In addition, procedures have been implemented to govern the use of signs and labels inside containment.

- <u>As a necessary and required support function for ECCS and CSS, the sump strainers are within the STP 10 CFR 50.65 Maintenance Rule program</u>:

  - As part of the STP Corrective Action Program, condition reports written due to adverse conditions identified during the containment inspections or containment emergency sumps and strainers surveillances are reviewed for impact on Maintenance Rule scoped systems, as appropriate.

  - The STP Maintenance Rule program includes performance monitoring of functions associated with ECCS and CSS, including sump recirculation. The inclusion of the ECCS and CSS into the Maintenance Rule program and the assessment of acceptable system performance provide continued assurance of the availability for performance of the required functions.

- <u>PRA Updates</u>: For the purpose of monitoring future facility changes or other conditions that may impact the PRA results associated with GSI-191, appropriate changes to the as-built, as-operated plant are reflected in updates to the STP at-power PRA reference model. The STP PRA Program is a living program and, as such, is subject to periodic review and updates. These PRA model periodic updates are performed in accordance with STP procedures. The effect of changes to the at-power PRA Reference model are assessed to ensure impacts to GSI-191 PRA results are evaluated against the criteria in RG 1.174, and any significant findings or conclusions are identified, documented, and entered into the Corrective Action Program as appropriate.

- <u>Licensed Operator Training</u>: Licensed Operators are trained on indications of and actions in response to sump blockage issues related to GSI-191, and performance is evaluated during training scenarios designed to simulate plant responses.

  Operator actions required to respond to emergency sump clogging are currently trained on a biennial basis in the Licensed Operator Requalification program. Simulator training objectives are trained every two years on the topics of transfer to cold leg recirculation, transfer to hot leg recirculation, and total loss of Emergency Sump recirculation capability. Indications of sump blockage are included as part of the Licensed Operator training administered for Emergency Operating Procedure (EOP) performance of switchover activities in addition to general familiarization with the indications of loss of pump suction. Licensed Operator Training includes the monitoring of operating ECCS and CSS pumps during the evolution for transfer to cold leg recirculation (0POP05-EO-ES13, "Transfer To Cold Leg Recirculation") and hot leg recirculation (0POP05-EO-ES14, "Transfer To Hot Leg Recirculation"). Operator training also includes actions required on a total loss of Emergency Sump recirculation capability (0POP05-EO-EC11, "Loss of Emergency Coolant Recirculation"). 0POP05-EO-EC11 is trained on a biennial basis in the Licensed Operator Requalification program (LOR), and simulator scenarios are utilized for this training.

- Quality Assurance (QA): The STP QA program is implemented and controlled in accordance with the Operations Quality Assurance Plan (OQAP) and is applicable to SSCs to an extent consistent with their importance to safety, and complies with the requirements of 10CFR50, Appendix B and other program commitments as appropriate.

  The QA Program is implemented with documented instructions, procedures, and drawings which include appropriate quantitative and qualitative acceptance criteria for determining that prescribed activities have been satisfactorily accomplished. Procedures control the sequence of required inspections, tests, and other operations when important to quality. To change these controls, the individual procedure must be changed and a similar level of review and approval given to the original procedure is required. Such instructions, procedures, and drawings are reviewed and approved for compliance with requirements appropriate to their safety significance.

  QA program controls are applied to safety-related SSCs to provide a high degree of confidence that they perform safely and activities are performed as expected. The rigorous controls imposed by the QA program provide adequate quality control elements to ensure system component reliability for the required functions.

- STPNOC has adopted other programs that help provide early detection and mitigation of leakage in other applications. The proposed change does not involve any changes to ASME Section XI inspection programs or mitigation strategies that have been shown effective in early detection and mitigation of weld and material degradation in Class I piping applications.

3.3.5 Technical Evaluation Conclusion

The design and licensing basis descriptions of accidents requiring ECCS operation, including analysis methods, assumptions, and results provided in UFSAR Chapters 6 and 15 remain unchanged. This is based on the functionality of the ECCS and CSS during design basis accidents being confirmed by demonstrating that the calculated risk associated with GSI-191 for STP Units 1 and 2 is "Very Small" and less than the Region III acceptance guidelines defined by RG 1.174.

The performance evaluations for accidents requiring ECCS operation described in Chapters 6 and 15, based on the South Texas Project Units 1 and 2 Appendix K Large-Break Loss-of-

Coolant Accident (LBLOCA) analysis, demonstrate that for breaks up to and including the double-ended guillotine break of a reactor coolant pipe, the ECCS will limit the clad temperature to below the limit specified in § 50.46, and assure that the core will remain in place and substantially intact with its essential heat transfer geometry preserved.

The effects on long-term cooling due to debris accumulation on the ECCS and CSS containment sump strainers and the in-vessel effects following LOCAs that require recirculation flow from the containment sump to mitigate the event are the primary safety concerns of GSI-191. These concerns are addressed using a risk-informed analytical approach.

The STPNOC PRA and the engineering analysis supporting the GSI-191 analysis are representative of the as-built, as-operated plant. The STP PRA is compliant with RG 1.200 Revision 1 for internal events, and therefore, for the purpose of assessing the risk of internal events associated with GSI-191, is compliant with Regulatory Guide 1.200 Revision 2 for assessing the risk of internal events associated with LOCAs.

The results demonstrate that the calculated risk associated with GSI-191 concerns for STP Units 1 and 2 are very small and are less than the threshold for Region III defined by RG 1.174. Acceptable containment sump design in support of ECCS and CSS during design basis accidents is confirmed.

4.0 Regulatory Evaluation

4.1 Applicable Regulatory Requirements/Criteria

4.1.1 Regulatory Requirements

The following regulations apply to the proposed amendment. Approval of the proposed amendment is contingent upon approval of the requests for exemptions from these regulations as provided and justified in Enclosures 2-1 through 2-4.

- § 50.46(b)(5), "*Long-term cooling,*" states that after any calculated successful initial operation of the ECCS, the calculated core temperature shall be maintained at an acceptably low value and decay heat shall be removed for the extended period of time required by the long-lived radioactivity remaining in the core.

- General Design Criteria (GDC) 35, "*Emergency core cooling,*" states that a system to provide abundant emergency core cooling shall be provided. The system safety function shall be to transfer heat from the reactor core following any loss of reactor coolant at a rate such that (1) fuel and clad damage that could interfere with continued effective core cooling is prevented and (2) clad metal-water reaction is limited to negligible amounts.

  Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure."

- GDC 38, "*Containment heat removal*," states that a system to remove heat from the reactor containment shall be provided. The system safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any LOCA and maintain them at acceptably low levels.

  Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.

- GDC 41, "*Containment atmosphere cleanup*," states that systems to control fission products, hydrogen, oxygen, and other substances which may be released into the reactor containment shall be provided as necessary to reduce, consistent with the functioning of other associated systems, the concentration and quality of fission products released to the environment following postulated accidents, and to control the concentration of hydrogen or oxygen and other substances in the containment atmosphere following postulated accidents to assure that containment integrity is maintained.

4.1.2 Regulatory Guidance

NRC Regulatory Guide 1.174, "An Approach for using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," provides the NRC staff's recommendations for using risk information in support of licensee-initiated Licensing Basis changes to a nuclear power plant that require NRC review and approval. This regulatory guide describes an acceptable approach for assessing the nature and impact of proposed Licensing Basis changes by considering engineering issues and applying risk insights.

In implementing risk-informed decision making, Licensing Basis changes are expected to meet a set of key principles. These principles include the following:

1. *The proposed change meets the current regulations unless it is explicitly related to a requested exemption (i.e., a specific exemption under 10 CFR 50.12, "Specific Exemptions").*

   The exemption request in Enclosure 2 to this letter implements this principle.

2. *The proposed change is consistent with a defense-in-depth philosophy.*

   The proposed change is consistent with the defense-in-depth philosophy in that the following aspects of the facility design and operation are unaffected:

   - Functional requirements and the design configuration of systems
   - Existing plant barriers to the release of fission products
   - Design provisions for redundancy, diversity, and independence

- Plant's response to transients or other initiating events
- Preventive and mitigative capabilities of plant design features

The STP risk-informed approach analyzes a full spectrum of LOCAs, including double-ended guillotine breaks for all piping sizes up to and including the largest pipe in the reactor coolant system (RCS). By requiring that mitigative capability be maintained in a realistic and risk-informed evaluation of GSI-191 for a full spectrum of LOCAs, the approach ensures that defense-in-depth is maintained.

3. *The proposed change maintains sufficient safety margins.*

   The proposed change does not involve a change in any functional requirements or the configuration of plant SSCs. The safety analyses in the UFSAR are unchanged. Therefore, sufficient safety margins associated with the design will be maintained by the proposed change.

4. *When proposed changes result in an increase in CDF or risk, the increases should be small and consistent with the intent of the Commission's Safety Goal Policy Statement.*

   The proposed change is defined as the risk associated with GSI-191 concerns. Using engineering analysis and the PRA this risk has been calculated and shown to be less than the threshold for Region III, "Very Small Changes," and is therefore consistent with the Commission's Safety Goal Policy Statement

5. *The impact of the proposed change should be monitored using performance measurement strategies.*

   A description is provided in Section 3.3.4 of the STP programmatic requirements that ensure the potential for debris loading on the sump does not materially increase. As noted in Section 3.3.4, STP has committed to estimating the effect of any change to or error in the PRA model used to evaluate the risk associated with GSI-191 and to report any significant change or error, in support of the LAR.

NRC Regulatory Guide 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," describes one acceptable approach for determining whether the quality of the PRA, in total or the parts that are used to support an application, is sufficient to provide confidence in the results, such that the PRA can be used in regulatory decision-making for light-water reactors. The STPNOC PRA model used for the risk-informed approach for addressing GSI-191 concerns is in compliance with Revision 1 of RG 1.200.

4.1.3 Technical Specifications

As concluded by the evaluations described below, the proposed amendment does not require a change to the Technical Specifications (TS).

10 CFR 50.36 Evaluation

10 CFR 50.36(b) requires each license authorizing operation of a production or utilization facility of a type described in §50.21 or §50.22 will include technical specifications. The technical specifications will be derived from the analyses and evaluation included in the safety analysis report, and amendments thereto, submitted pursuant to §50.34. The Commission may include such additional technical specifications as the Commission finds appropriate.

10 CFR 50.36(c) states that the technical specifications will include items in the following categories:

(1) <u>*Safety limits, limiting safety system settings, and limiting control settings*</u>.

The proposed amendment does not propose any changes to the technical specifications safety limits, limiting safety system settings or limiting control settings, or propose any new safety limits, limiting safety system settings or limiting control settings.

As discussed in the NRC SER on NEI 04-07 (Reference 9):

> *While not a component of the 10 CFR 50.46 ECCS evaluation model, the calculation of sump performance is necessary to determine if the sump and the residual heat removal system are configured properly to provide enough flow to ensure long-term cooling, which is an acceptance criterion of 10 CFR 50.46. Therefore, the staff considers the modeling of sump performance as the validation of assumptions made in the ECCS evaluation model. Since the modeling of sump performance is a boundary calculation for the ECCS evaluation model, and acceptable sump performance is necessary for demonstrating long-term core cooling capability (10 CFR 50.46(b)(5)), the requirements of 10 CFR 50.46 are applicable.*

The proposed change to the UFSAR does not involve any changes to the other acceptance criteria of 10 CFR 50.46 (peak cladding temperature, maximum cladding oxidation, maximum hydrogen generation, and coolable geometry). The proposed change uses a risk-informed method, rather than a deterministic method, to reconstitute the design basis of the sumps and demonstrate acceptable sump performance, consistent with the requirements of 10 CFR 50.46:

- Accident sequences from a full spectrum of LOCAs are analyzed to provide assurance that the most severe postulated LOCAs are included in the model.
- The supporting engineering analysis for the risk-informed method includes justification for showing that the analyses realistically describe the behavior of the plant during a LOCA. Accident sequences are analyzed in a realistic time-dependent manner.
- The supporting analyses are informed by applicable experimental data where appropriate.
- Uncertainties in the analyses are identified and assessed so that uncertainty in the calculated results is estimated. For input into the PRA, uncertainty

propagation is used to determine the probabilities of various failures potentially leading to core damage.

In the PRA model, the demand recirculation failure probability includes assessment of a loss of NPSH for pumps among the basic events as described for the STP risk-informed methodology, and accident sequences from a full spectrum of postulated LOCAs are analyzed. This approach demonstrates a high level of probability that adequate core cooling is maintained by maintaining a positive NPSH margin. As stated in (Ref NEI 04-07 SER), maintaining a positive NPSH margin to demonstrate adequate core cooling shows that the 10 CFR 50.46 acceptance criteria should not be challenged.

The results of the risk-informed method confirm that the ECCS cooling performance calculated by the Appendix K Evaluation Model demonstrates with a high level of probability that the long-term cooling criterion of 10 CFR 50.46(b)(5) would not be exceeded. The results also show acceptable CSS performance for containment heat removal and for maintaining the containment as an effective fission product barrier, as demonstrated by acceptable sump performance. These conclusions are based on the risk-informed approach meeting the key principles of RG 1.174, and the PRA results that show the residual risk associated with GSI-191 is less than the threshold for "Very Small Changes" in Region III as defined in RG 1.174.

(2) Limiting conditions for operation.

Limiting conditions for operation are the lowest functional capability or performance levels of equipment required for safe operation of the facility. The proposed amendment does not propose any changes to the functional capability or performance levels of the Emergency Core Cooling System or the Containment Spray System.

The criteria for establishing a technical specification limiting condition for operation were evaluated.

(A) Criterion 1. Installed instrumentation that is used to detect, and indicate in the control room, a significant abnormal degradation of the reactor coolant pressure boundary.

The proposed changes do not affect the instrumentation provided in the Technical Specifications that are used to detect degradation of the reactor coolant pressure boundary, including containment leak detection, containment temperature and pressure, and containment radiation levels.

The proposed changes do not affect the installed instrumentation used to detect inadequate recirculation flow and inadequate core flow conditions resulting from postulated LOCAs. As discussed in item (1) above, the proposed changes do not impact an initial condition of a design basis accident or transient analysis that either assumes the failure of, or presents a challenge to the integrity of a fission product barrier.

(B) *Criterion 2. A process variable, design feature, or operating restriction that is an initial condition of a design basis accident or transient analysis that either assumes the failure of or presents a challenge to the integrity of a fission product barrier.*

The proposed changes do not impact any of the process variables, design features, or pose any operating restrictions that are an initial condition of a design basis accident or transient analysis that either assumes the failure of, or presents a challenge to the integrity of a fission product barrier.

The proposed changes reconstitute the design basis for the sumps to validate the assumptions in the Appendix K ECCS Evaluation model that demonstrates acceptable ECCS performance for postulated LOCAs. The existing LCO's for ECCS control the aspects of the design and plant conditions required to satisfy 10 CFR 50.46. The risk-informed method shows that the sump design supports the conclusion that there is a high probability that the long term cooing criterion would not be exceeded. The results also show that the existing LCO's are adequate for controlling the specified safety functions associated with CSS.

(C) *Criterion 3. A structure, system, or component that is part of the primary success path and which functions or actuates to mitigate a design basis accident or transient that either assumes the failure of or presents a challenge to the integrity of a fission product barrier.*

The proposed amendment proposes a revision to the UFSAR to describe evaluations performed to address GSI -191 concerns. The evaluation concludes that the ECCS systems will operate with a high probability following a LOCA when considering the impacts and effects described by GSI-191. As discussed in item (1) above, the proposed changes reconstitute the design basis for acceptable sump performance during recirculation mode for ECCS and CSS to mitigate postulated LOCAs. No changes are proposed to the limiting condition for operation of the ECCS or CSS. The proposed amendment does not propose any change to how the ECCS or CSS functions or actuates to mitigate a design basis accident or transient.

(D) *Criterion 4. A structure, system, or component which operating experience or probabilistic risk assessment has shown to be significant to public health and safety.*

The proposed amendment does not introduce the need for any new structure, system or component that is required to support the conclusions of the safety analysis. The PRA results show that the risk associated with the change is very small and does not warrant any technical specification under Criterion 4.

The existing LCO action statement completion times were also evaluated and determined to remain acceptable based on the very small risk contribution associated with the proposed change.

(3) *Surveillance requirements.* Surveillance requirements are requirements relating to test, calibration, or inspection to assure that the necessary quality of systems and components is maintained, that facility operation will be within safety limits, and that the limiting conditions for operation will be met.

The technical specification surveillance requirements (TS SRs) in place will continue to demonstrate that the safety significant measurable functions are satisfied to assure the operability of the ECCS and Containment Spray System, and provide assurance that the containment sump will perform its design function.

To demonstrate operability for each ECCS subsystem, TS SR 4.5.2.c specifies visual inspections of the containment for latent debris to be performed for establishing and maintaining Containment Integrity:

> *By a visual inspection which verifies that no loose debris (rags, trash, clothing, etc.) is present in the containment which could be transported to the containment sump and cause restriction of the pump suctions during LOCA conditions. This visual inspection shall be performed:*
>
> *1) For all accessible areas of the containment prior to establishing CONTAINMENT INTEGRITY, and*
>
> *2) Of the areas affected within containment at the completion of each containment entry when CONTAINMENT INTEGRITY is established.*

TS SR 4.5.2.c is implemented by STP procedures 0PSP03-XC-0002, "Initial Containment Inspection to Establish Integrity," and 0PSP03-XC-0002A, "Partial Containment Inspection (Containment Integrity Established), Visual Inspection of Containment for Loose Debris."

- Containment inspections are performed prior to entering MODE 4 during plant startup, and include an elevation-by-elevation check to confirm the absence of loose debris that could clog the sumps, that all temporary storage box lids are in place and secured, and that all tool cabinet doors are closed and secured.
- Walk-downs are performed by station management and Operations and a final acceptance walk-down is performed by Operations to confirm all requirements for Containment Integrity are met and to assure the containment building is free of loose debris.

Of particular relevance to GSI-191, TS SR 4.5.2.d. was previously revised to be consistent with the installation of the new advanced design sump strainers, and requires visual inspections of the sumps during each refueling outage:

> *At least once per 18 months by a visual inspection of the containment sump and verifying that the subsystem suction inlets are not restricted by debris and that the sump components show no evidence of structural distress or abnormal corrosion.*

TS SR 4.5.2.d is implemented by STP procedure 0PSP04-XC-0001, "Inspection of Containment Emergency Sumps and Strainers Unit #1 1-A, 1-B, 1-C Unit #2 2-A, 2-B, 2-C." Visual inspections of each sump, the entire exterior and the interior of the strainers, and the vortex suppressor are performed. The sump inspection procedure includes specific criteria to assure the following:

- No external evidence of structural distress or abnormal corrosion
- No pathways that would allow foreign objects or debris to enter the sump
- No structural joints with gaps larger than 0.095"
- No gaps in the strainer modules or associated piping fit-up connections
- No foreign materials remain on or lodged into the gaps of the strainer modules.
- No foreign material inside the strainer core tubes, including the two strainer modules connected on a 45 degree angle on sumps "A" and "B".
- No restrictions in the sump suction inlets.
- No foreign objects, debris, or boron crystal build-up in the sumps, and that the sumps are dry.

The TS SR for visual inspections of the containment and emergency sumps support the specified safety functions for CSS in the recirculation mode also supported by the emergency sumps. Therefore, additional surveillance requirements are not warranted.

(4) *Design features. Design features to be included are those features of the facility such as materials of construction and geometric arrangements, which, if altered or modified, would have a significant effect on safety and are not covered in categories described in items (1), (2), and (3) above.*

The proposed amendment does not propose any change to design features of the plant. As discussed above, the risk associated with GSI-191 issues for STP is very low and does not warrant the discussion of any additional design features in the technical specifications.

(5) *Administrative controls. Administrative controls are the provisions relating to organization and management, procedures, recordkeeping, review and audit, and reporting necessary to assure operation of the facility in a safe manner.*

The administrative controls in the technical specifications provide assurance that the facility will be operated in a safe manner. The proposed amendment proposes a revision to the UFSAR the risk-informed evaluation that concludes the ECCS and CSS will operate with a high probability following a LOCA when considering the impacts and effects described by GSI-191. No changes are proposed to any processes and procedures regarding operation of the ECCS or CSS.

Definition of Operable/Operability

Although a separate limiting condition for operation (LCO) is not being established, considerations regarding sump performance and its effect on existing LCOs (for example TS 3.5.2, 3.5.3.1 and 3.6.2.1) are already addressed by the TS definition of Operability.

STP TS Definition 1.20 states:

> *A system, subsystem, train, component or device shall be OPERABLE or have OPERABLITY when it is capable of performing its specified function(s), and when all necessary attendant instrumentation, controls, electrical power, cooling or seal water, lubrication or other auxiliary equipment that are required for the system, subsystem, train, component, or device to perform its function(s) are also capable of performing their related support function(s).*

Operability for ECCS and CSS is based on the capability of each subsystem to perform its specified safety functions. Operability for ECCS is supported by acceptable performance of the sump strainers to provide the necessary support functions required for sufficient core cooling during the recirculation mode for all postulated break sizes ranging up to the double-ended guillotine break of the largest RCS cold leg pipe. Operability for CSS is similarly supported by the acceptable performance of the sump strainers during recirculation mode to support the specified safety functions.

Conditions that could potentially affect the ability of the containment emergency sump to support the LCO requirements of the ECCS or CSS would be evaluated and addressed by existing station procedures and processes and in accordance with the guidance of NRC Inspection Manual, Part 9900 (as discussed in Regulatory Issue Summary (RIS) 2005-20) for degraded and non-conforming conditions. Evaluations consider a change in condition inside the containment related to GSI-191 concerns, such as changes or additions to containment coatings and thermal insulation in the containment. Evaluations also consider how the condition may affect the inputs and assumptions to the supporting engineering analysis for the PRA model, as described in detail in Enclosure 4-3.

Operability determinations would be required to address certain conditions in containment that may affect debris loading of the strainers. Likely conditions include discovery of more fibrous insulation in containment than expected or discovery of latent or miscellaneous fibrous debris. Applicable operability determinations should consider the specific design inputs used in the CASA Grande analysis discussed in Volume 3 Section 2.2 (Enclosure 4-3). For immediate operability determinations, reasonable expectation that the SSCs are operable may be based on comparing a discovered condition with the expected debris loading in the containment, such as shown in the table above. A discovered condition that may exceed the values shown in the table does not preclude reasonable expectation of operability. Due to the complexity of the analysis, the potential exists for conditions to be discovered which are not represented by the values in the table, and for which follow-up evaluations will be required.

When warranted, an immediate operability determination will be followed by a prompt operability determination that will apply additional information and supporting analyses to confirm the immediate operability determination. Evaluations may consider additional information provided in the inputs to the CASA Grande analysis as well as the identified

conservatisms associated with the categories of major assumptions in the CASA Grande analysis, Section 3 of Volume 3 (Enclosure 4-3).:
For a discovered condition that potentially affects debris quantities in containment, the applicable CASA Grande input parameters and assumptions provide a means for immediate operability determinations and follow-up determinations, as warranted, to evaluate the impact on containment sump performance. If such a condition were determined to affect the ability of the ECCS or CSS to perform its specified function such that there is not reasonable expectation of operability, then the existing LCOs and action statements provide sufficient requirements to restore the system to operable or place the unit in a safe condition.

Conclusion

Based on the above evaluations of the 10 CFR 50.36(c) categories, the existing TS SR that support the proposed change, and the adequacy of the TS definition of Operable/Operability to address the proposed change as it relates to the required support function of the ECCS containment emergency sumps and strainers for the specified safety functions of the ECCS and CSS, no changes are needed to the operability requirements for ECCS and CSS, and no changes to the existing TS Action Statements are needed.

Changes to the Technical Specifications Bases

Although the above evaluations conclude that no changes are required to the TS, approval of the proposed changes requires conforming changes to the STP TS Bases to reflect the reconstituted design basis for the sumps and sump strainers. Changes to the TS Bases are provided for information only in Attachment 3 to this Enclosure, to be implemented following NRC approval of the LAR.

4.2 Precedents

The NRC plans to use STP Units 1 and 2 as a pilot for other licensees choosing to a risk-informed approach for closure of GSI-191 (Reference 14). The STP piloted risk-informed approach is expected to result in substantial benefit to both the NRC and industry in support of the development and implementation of risk-informed resolution of GSI-191.

The proposed amendment and accompanying exemption requests provide an approach for other licensees to revise their Licensing Basis in order to close GSI-191.

4.3 No Significant Hazards Consideration Determination

STPNOC has evaluated whether or not a significant hazards consideration is involved with the proposed amendment by focusing on the three standards set forth in 10 CFR 50.92, "Issuance of amendment," as discussed below:

1. **Does the proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?**

   Response: No.

   The proposed change adds the results of a risk-informed evaluation to the UFSAR that concludes the ECCS and CSS will operate with a high probability following a LOCA when considering the impacts and effects of debris accumulation on containment emergency sump strainers in recirculation mode, as well as core flow blockage due to in-vessel effects, following loss of coolant accidents (LOCAs).

   The proposed change does not implement any physical changes to the facility or any SSCs, and does not implement any changes in plant operation. The proposed change confirms that required SSCs supported by the containment sumps will perform their safety functions as required, and does not alter or prevent the ability of SSCs to perform their intended function to mitigate the consequences of an accident previously evaluated within the acceptance limits. The safety analysis acceptance criteria in the UFSAR continue to be met for the proposed change. The proposed change does not affect initiating events. The proposed change does not significantly affect the operation of the containment systems needs to ensure that there is a large margin between the temperature and pressure conditions reached in the containment and those that would lead to failure so that there is a high degree of confidence that damage of the containment cannot occur.

   The calculated risk associated with the proposed change is very small and less than the threshold for Region III as defined by RG 1.174, for both CDF and LERF. Therefore, the proposed change does not involve a significant increase in the probability or consequences of any the accident previously evaluated in the UFSAR.

2. **Does the proposed change create the possibility of a new or different kind of accident from any accident previously evaluated?**

   Response: No.

The proposed change neither installs nor removes any plant equipment, nor alters the design, physical configuration, or mode of operation of any plant structure, system or component. The proposed change does not introduce any new failure mechanisms or malfunctions that can initiate an accident. The proposed change does not introduce failure modes, accident initiators, or equipment malfunctions that would cause a new or different kind of accident. Therefore, the proposed change does not create the possibility for a new or different kind of accident from any previously evaluated.

3. **Does the proposed change involve a significant reduction in a margin of safety?**

   Response: No.

   The proposed change does not involve a change in any functional requirements, the configuration, or method of performing functions of plant SSCs. The effects from a full spectrum of LOCAs, including double-ended guillotine breaks for all piping sizes up to and including the largest pipe in the reactor coolant system, are analyzed. Appropriate redundancy and consideration of loss of offsite power and worst case single failure are retained, such that defense-in-depth is maintained.

   The risk-informed method demonstrates the containment sumps will continue to support the ability of safety related components to perform their design functions. The proposed change does not alter the manner in which safety limits are determined or acceptance criteria associated with a safety limit. The proposed change does not implement any changes to plant operation, and does not significantly affect SSCs that respond to safely shutdown the plant and to maintain the plant in a safe shutdown condition. The proposed change does not significantly affect the existing safety margins in the barriers for the release of radioactivity. There are no changes to any of the safety analyses in the UFSAR. Therefore, the proposed change does not involve a significant reduction in a margin of safety.

Based on the above, STPNOC concludes that the proposed amendments do not involve a significant hazards consideration under the standards set forth in 10 CFR 50.92(c), and accordingly, a finding of "no significant hazards consideration" is justified.

4.4 Conclusion

Based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations contingent upon approval of the exemption requested in Enclosure 2 to this letter, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

5.0 Environmental Consideration

A review has determined that the proposed amendment would change a requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR 20. However, the proposed amendment does not involve (i) a significant hazards consideration, (ii) a significant change in the types or a significant increase in the amounts of any effluents that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

6.0 References

1. Generic Safety Issue (GSI)-191, "Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance"

2. Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," Revision 2 (ML100910006)

3. Regulatory Guide 1.82, "Sumps for Emergency Core Cooling and Containment Spray Systems," Proposed Revision 1, May 1983

4. STPNOC letter, David W. Rencurrel to NRC Document Control Desk, "Proposed Change to Surveillance Requirement 4.5.2.d," May 21, 2007, NOC-AE-07002156 (ML0715605)

5. STPNOC letter, David W. Rencurrel to NRC Document Control Desk, "Response to NRC Request for Additional Information on Proposed Change to Surveillance Requirement 4.5.2.d (TAC Nos. MD5705, MD5706)," November 26, 2007, NOC-AE-07002225 (ML073380340)

6. "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Amendment Nos. 183 and 170 to Facility Operating License Nos. NPF-76 and NPF-80 STP Nuclear Operating Company, et al., South Texas Project, Units 1 and 2, Docket Nos. 50-498 and 50-499," March 25, 2008 (ML080360321)

7. STPNOC letter, David W. Rencurrel to NRC Document Control Desk, "Supplement 4 to the Response to Generic Letter 2004-02 (TAC Nos. MC4719 and MC4720)," December 11, 2008, NOC-AE-08002372 (ML083520326)

8. NEI 04-07, "Pressurized Water Reactor Sump Performance Evaluation Methodology," Volume 1 "Pressurized Water Reactor Sump Performance Evaluation Methodology," Revision 0, December 2004 (ML050550138)

9. NEI 04-07, "Pressurized Water Reactor Sump Performance Evaluation Methodology," Volume 2 "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to NRC Generic Letter 2004-02, Revision 0, December 6, 2004," Revision 0, December 2004 (ML050550156)

10. WCAP-16406-P-A, "Evaluation of Downstream Sump Debris Effects in Support of GSI-191," Revision 1, March 2008 (ML081000025)

11. WCAP-16793-NP," Evaluation of Long-Term Cooling Considering Particulate and Chemical Debris in the Recirculating Fluid," Revision 0, May 2007 (ML071580139)

12. NEI 02-01, "Condition Assessment Guidelines: Debris Sources Inside PWR Containments," Revision 1, September 2002 (ML030420318)

13. STPNOC letter, J. W. Crenshaw, STPNOC, to NRC Document Control Desk, "Status of the South Texas Project Risk-Informed (RI) Approach to Resolve Generic Safety Issue (GSI)-191," NOC-AE-11002775, December 14, 2011 (ML11354A386)

14. Commission SECY Paper, "Closure Options for Generic Safety Issue - 191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance," SECY-12-0093, July 9, 2012 (ML121320270)

15. STPNOC letter, T. H. Cloninger to NRC Document Control Desk, "Response to Generic Letter 98-04, 'Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System After a Loss-of-Coolant Accident Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment,'" November 11, 1998, NOC-AE-000350 (Legacy No. 9811230146)

16. WCAP-16530-NP, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191," Revision 0, February 2006 (ML060890509)

17. WCAP-16793-NP," Evaluation of Long-Term Cooling Considering Particulate and Chemical Debris in the Recirculating Fluid," Revision 2, October 2011 (ML11292A020)

18. Regulatory Guide 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities"

Attachment 1 to Enclosure 3

List of Commitments

List of Commitments

The following table identifies the actions to which STP Nuclear Operating Company (STPNOC) has committed. Statements in the submittal with the exception of those in the table below are provided for information purposes and are not considered regulatory commitments.

Commitment	**Tracking Number**	**Scheduled Completion Date**
The STP UFSAR will be revised to include the changes provided in Attachment 2 to Enclosure 3, "Licensing Amendment Request for STP Piloted Risk-Informed Approach to Closure for GSI-191."	CR 11-4249-9	90 days following approval of LAR

Attachment 2 to Enclosure 3

STPEGS UFSAR Page Markups

STPEGS UFSAR Page Markups

The changes to the South Texas Project Electric Generating Station (STPEGS) Updated Final Safety Analysis Report (UFSAR) are provided for NRC review and approval for the purpose of resolving Generic Safety Issue (GSI)-191, "Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance." The risk-informed approach following the guidance of RG 1.174 provided as justification for the changes. Changes to the revised parts of the UFSAR will be done in accordance with 10CFR50.59 since the criteria of 10CFR50.59 are still the relevant and appropriate change criteria.

The design and licensing basis descriptions of accidents requiring ECCS operation, including analysis methods, assumptions, and results provided in UFSAR Chapters 6 and 15 remain unchanged. The performance evaluations for accidents requiring ECCS operation described in Chapters 6 and 15, based on the South Texas Project Units 1 and 2 Appendix K Large-Break Loss-of-Coolant Accident (LBLOCA) analysis, demonstrate that for breaks up to and including the double-ended guillotine break of a reactor coolant pipe, the ECCS will limit the clad temperature to below the limit specified in § 50.46, and assure that the core will remain in place and substantially intact with its essential heat transfer geometry preserved.

The results of the risk-informed method determine acceptable containment sump design and performance and reconstitute the licensing bases for the supported ECCS and CSS specified functions required during recirculation mode following postulated LOCAs, for the purpose of resolving GSI-191.

Changes to the UFSAR are shown on the following pages in gray highlight.

3.1.2.4.6.1 Evaluation Against Criterion 35 – The ECCS is provided to cope with any LOCA in the plant design basis. Abundant cooling water is available in an emergency to transfer heat from the core at a rate sufficient to maintain the core in a coolable geometry and to assure that clad metal/water reaction is limited to less than 1 percent. Adequate design provisions are made to assure performance of the required safety functions even with a single failure.

Details of the capability of the systems are included in Section 6.3. An evaluation of the adequacy of the system functions is included in Chapter 15. Performance evaluations have been conducted in accordance with 10CFR50.46 and 10CFR50 Appendix K.

For resolution of GSI-191, a risk-informed approach meeting the guidance in RG 1.174 was used to confirm acceptable containment sump performance for ECCS and CSS in recirculation mode following postulated LOCAs, and to validate assumptions used for the ECCS performance evaluations to assure long-term cooling performance. The risk-informed approach described in Appendix 6A provided justification for an exemption from the implicit GDC 35 requirement to demonstrate acceptable performance using a deterministic evaluation.

3.1.2.4.9.1 Evaluation Against Criterion 38 – The CHRS consists of the CSS, the Reactor Containment Fan Cooler (RCFC) Subsystem and the residual heat removal (RHR) heat exchangers. The CHRS acts in conjunction with the Safety Injection System to remove heat from the Containment. The CHRS is designed to accomplish the following functions in the unlikely event of a LOCA: to rapidly condense the steam within the Containment in order to prevent over-pressurization during blowdown of the RCS; and to provide long-term continuous heat removal from the Containment.

Initially, the CSS and the high-and low-head safety injection (HHSI and LHSI) pumps take suction from the refueling water storage tank (RWST). During the recirculation phase, the CSS and the HHSI and LHSI pumps take suction from the Containment sumps and emergency sumps.

The CHRS is divided into three trains. Each train is sized to remove 50 percent of the system design heat load at the start of recirculation. Each train of the CHRS is supplied power from a separate independent Class 1E bus. The redundancy and capability of the Offsite and Emergency Power Systems are presented in the evaluation against Criterion 17. Redundant system trains and emergency diesel power supplies provide assurance that system safety functions can be accomplished.

For further discussion, see the following sections of the UFSAR:

Residual Heat Removal System	5.4.7
Containment Systems	6.2
Engineered Safety Features Actuation System	7.3
Onsite Power System	8.3
Accident Analysis	15.0

For resolution of GSI-191, a risk-informed approach meeting the guidance in RG 1.174 was used to confirm acceptable containment sump performance for ECCS and CSS in recirculation mode following postulated LOCAs, and to validate assumptions used for the ECCS performance evaluations to assure long-term cooling performance. The risk-informed approach described in Appendix 6A provided justification for an exemption from the implicit GDC 38 requirement to demonstrate acceptable performance using a deterministic evaluation.

3.1.2.4.12.1 Evaluation Against Criterion 41 – The CSS is provided to reduce the concentration and quantity of fission products in the Containment atmosphere following a LOCA. Per 10CFR50.44, hydrogen recombiners are no longer required for design basis accidents.

The equilibrium sump pH is maintained by trisodium phosphate (TSP) contained in baskets on the containment floor. The initial CSS water and spilled RCS water dissolves the TSP into the containment sump allowing recirculation of the alkaline fluid. Each unit is equipped with three 50-percent spray trains taking suction from the Containment sump. Each Containment spray train is supplied power from a separate bus. Each bus is connected to both the Offsite and the Standby Power Supply Systems. This assures that for Onsite or for Offsite Electrical Power System failure, their safety function can be accomplished, assuming a single failure.

Post-accident combustible gas control is assured by the use of the Supplementary Containment Purge Subsystem.

For further discussion, see the following sections of the UFSAR:

Containment Systems	6.2
Containment Spray System – Iodine Removal	6.5.2
Containment Hydrogen Sampling System	7.6.5
Containment HVAC System	9.4.5
Accident Analysis	15.0

For resolution of GSI-191, a risk-informed approach meeting the guidance in RG 1.174 was used to confirm acceptable containment sump performance for ECCS and CSS in recirculation mode following postulated LOCAs, and to validate assumptions used for the ECCS performance evaluations to assure long-term cooling performance. The risk-informed approach described in Appendix 6A provided justification for an exemption from the implicit GDC 41 requirement to demonstrate acceptable performance using a deterministic evaluation.

TABLE 3.12-1
REGULATORY GUIDE MATRIX

ABBREVIATIONS:

A Conform to guide

No.	Regulatory Guide Title	UFSAR Reference	Revision Status On STPEGS	STPEGS Position
1.82	Sumps for Emergency Core Cooling and Containment Spray Systems	6.2.2.1.2 6.2.2.2.3 6.3.4.1	Proposed Rev 1 (5/83)	A See Note 103

NOTES

103 NRC Generic Letter 2004-02 (GL 04-02) "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," required licensees to evaluate the ECCS and CSS recirculation functions based on the potential susceptibility of sump screens to debris blockage during design basis accidents. Refer to Section 6.2.2.1.2.

6.2.2.1.2 <u>Containment Emergency Sump Design Bases</u>:

The Containment emergency sump meets the following design bases:

1. Sufficient capacity and redundancy to satisfy the single-failure criteria. To achieve this, each CSS/ECCS train draws water from a separate Containment emergency sump.

2. Capable of satisfying the flow and net positive suction head (NPSH) requirements of the ECCS and the CSS under the most adverse combination of credible occurrences. This includes minimizing the possibility of vortexing in the sump.

3. Minimizes entry of high-density particles (specific gravity of 1.05 or more) or floating debris into the sump and recirculating lines.

4. Sumps are designed in accordance with RG 1.82, proposed revision 1, May 1983 and with Generic Letter 2004-02 as described in ~~NOC-AE-08002372~~ Appendix 6A.

6.2.2.2.3 Containment Emergency Sump Description:

At the beginning of the recirculation phase, the minimum water level above the Containment floor is adequate to provide the required NPSH for the ECCS and CSS pumps. The sumps are designed to RG 1.82, proposed revision 1, May 1983 and to the requirements of Generic Letter 2004-02 as described in ~~NOC-AE-08002372~~ Appendix 6A. The sump structures are designed to limit approach flow velocities to less than 0.009 ft/sec permitting high-density particles to settle out on the floor and minimize the possibility of clogging the strainers. The sump structures are designed to withstand the maximum expected differential pressure imposed by the accumulation of debris.

6.2.2.3.5 Pump Net Positive Suction Head Requirements:

The minimum available net positive suction head (NPSH) for the CSS pumps is such that an adequate margin is maintained between the required and the available NPSH for both the injection and recirculation phase, ensuring the proper operation of the CSS as discussed in Appendix 6A. Recirculation operation gives the limiting NPSH requirements for the CSS pumps and is discussed in Appendix 6A.

The Westinghouse CSS pump design provides for the NPSH requirement to be met by the inherent design of the pump. CSS pumps are vertical motor-driven pumps, each sitting in an individual barrel. The design calls for a distance of 15 ft in this barrel between the suction nozzle centerline and the pump first-stage impeller. The 15-ft liquid-head in the pump barrel is thus expected to inherently satisfy the 15-ft NPSH requirement.

The analysis of available NPSH to the CSS pumps concerns itself with the NPSH at the pump suction nozzle, located at the top of the barrel. Since the pump barrels provide the required NPSH at the first-stage impeller, the piping layout need provide only sufficient NPSH at the pump suction nozzle to prevent flashing in the barrel.

Two modes of operation have been analyzed for the CSS pumps:

1. Pump taking suction from the RWST and delivering spray to the Containment

2. Pump taking suction from the Containment sump and delivering spray to the Containment

Case 2 represents the "worst case" since it gives the minimum available NPSH.

The assumptions and conservatisms used in the analysis are listed below. No exceptions are taken to RG 1.1.

1. Containment pressure equals the vapor pressure of the sump water.

2. The runout flows of each pump are used to account for maximum friction loses.

The minimum flood level in Containment is determined by considering the quantities of water trapped by the refueling cavity.

The results of the analysis show the available NPSH at the first-stage impeller of the CSS pumps to be greater than the required NPSH and show that the fluid at the suction flange is subcooled as qualified by the description in Appendix 6A for acceptable sump design and CSS pump performance in the recirculation mode. There is sufficient NPSH at the suction nozzle to prevent flashing in the barrel, and the analysis meets the guideline of RG 1.1. The NPSH parameters are listed in Table 6.2.2-4.

NPSH for the ECCS pumps is addressed in Section 6.3.

TABLE 6.2.2-4

CSS PUMP NPSH PARAMETERS

Required NPSH at Max Flow Rate, ft (max)	16.4
Available NPSH, ft (from RWST)	56.1
(From RCB Emergency Sump)	>17.6 (Note 1)

Note 1: The value is the result of a deterministic analysis used as an indication of pump performance. Acceptable pump performance in the recirculation mode is evaluated using a risk-informed approach described in Appendix 6A.

6.3.2.2 Equipment and Component Descriptions.

Net Positive Suction Head

Available and required net positive suction head (NPSH) for ECCS pumps are shown in Table 6.3-1. The safety intent of Regulatory Guide (RG) 1.1 is met by the design of the ECCS such that adequate NPSH is provided to system pumps.

The NPSH available for the injection mode is determined from the elevation head and the vapor pressure (atmospheric) of the water in the RWST, and the pressure drop in the suction piping from the tanks to the pumps. The NPSH evaluation is based on all pumps operating at maximum flow rate with no credit taken for the elevation head in the tank and full penalty assumed for head loss in the suction lines.

In addition to considering the static head and suction line pressure drop, the calculation of available NPSH in the recirculation mode assumes that the vapor pressure of the liquid in the sump is equal to the Containment ambient pressure. This assures that the actual available NPSH is always greater than the calculated NPSH.

See Appendix 6A for discussion of the pump performance in the recirculation mode.

TABLE 6.3-1

EMERGENCY CORE COOLING SYSTEM
COMPONENT PARAMETERS

High Head Safety Injection Pumps

Required NPSH at max. flow rate, ft (max)	16.1
Available NPSH, ft (From RWST)	55.8
(From RCB Emergency Sump)	> 17.8 (Note 1)

Low Head Safety Injection Pumps

Required NPSH, ft (max)	16.5
Available NPSH, ft (From RWST)	55.1
(From RCB Emergency Sump)	> 18.0 (Note 1)

Note 1: The value is the result of a deterministic analysis used as an indication of pump performance. Acceptable pump performance in the recirculation mode is evaluated using a risk-informed approach described in Appendix 6A.

NOTE: UFSAR change for Appendix 6A shown below consists entirely of new content, therefore gray highlight is not used.

APPENDIX 6A

RISK-INFORMED APPROACH TO POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS

INTRODUCTION AND SUMMARY

NRC Generic Letter 2004-02 (GL 2004-02) "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," required licensees to perform an evaluation of the ECCS and CSS recirculation functions, and the flowpaths necessary to support those functions, based on the potential susceptibility of sump screens to debris blockage during design basis accidents requiring recirculation operation of ECCS or CSS. This Generic Letter resulted from the Generic Safety Issue (GSI) 191, "Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance." As a result of the evaluation required by GL 2004-02 and to ensure system function, sump design modifications were implemented (refer to Section 6.2.2.2.3).

GL 2004-02 sump performance evaluation activities, documented in References 6A-1 and 6A-2, included the following:

- Containment walkdowns
- Debris generation and transport analysis
- Calculation of required and available net positive suction head (NPSH)
- Screen requirements
- Screen structural analyses
- Potential or planned design/operational/procedural modifications
- Downstream effects
- Upstream effects
- Chemical effects

A risk-informed evaluation implemented in response to issues identified in GSI-191 provides high confidence that the sump design supports long-term core cooling following a design basis loss of coolant accident. The evaluation meets the acceptance guidelines in Regulatory Guide 1.174 (Reference 6A-3).

Acceptable sump design, based on meeting the acceptance guidelines in RG 1.174, demonstrates high probability of successful ECCS and CSS operation in recirculation mode following postulated LOCAs, with consideration of debris and other effects associated with GSI-191. This result reconstitutes the long term cooling licensing basis for meeting 10 CFR 50.46(b)(5) and provides closure for GSI-191. Demonstration of acceptable sump design using the risk-inform approach also reconstitutes the licensing basis for compliance with GDC 35, GDC 38 and GDC 41.

The use of a risk-informed method, rather than exclusively deterministic methods, demonstrates acceptable containment sump performance in support of ECCS and CSS operation in recirculation mode following postulated LOCAs. Therefore exemptions to 10 CFR 50.46(b)(5), GDC 35, GDC 38, and GDC 41 have been granted pursuant to 10 CFR 50.12.

DISCUSSION

The plant licensing basis considers long-term core cooling following a LOCA as identified in 10 CFR 50.46. Long-term cooling is supported by the ECCS which includes the Containment Spray (CS), the High Head Safety Injection (HHSI), the Low Head Safety Injection (LHSI), and the Residual Heat Removal (RHR) systems. Using a risk-informed approach to address the concerns of GSI-191, the probability associated with the operation of the ECCS to maintain long-term cooling following a LOCA has been quantified. The results show that the risk associated with GSI-191 concerns is less than the threshold for "Very Small Changes" in Region III as defined in Regulatory Guide 1.174.

The risk-informed method of analysis using an integrative approach models the underlying physical phenomena of the basic events and propagates uncertainties in the physical models.

In particular, the STP plant-specific PRA models the demand recirculation failure probability with the following basic events:

- Pressure drop due to build up of debris on the sump strainers with chemical effects resulting in loss of NPSH margin for the ECCS pumps
- Strainer mechanical collapse
- Air ingestion through the sump strainers
- Core blockage with chemical effects
- Boron precipitation in the core

The accident sequences are analyzed in a realistic time-dependent manner with uncertainty propagation to determine the probabilities of various failures potentially leading to core damage from a spectrum of location-specific pipe breaks for input into the PRA. The specific failure modes considered are:

1. Strainer head loss exceeds the NPSH margin for the pumps causing some or all of the ECCS and CSS pumps to fail.
2. Strainer head loss exceeds the strainer structural margin causing the strainer to fail, which subsequently results in larger quantities and larger sizes of debris being ingested into the ECCS and CSS.
3. Air intrusion exceeds the limits of the ECCS and CSS pumps causing degraded pump performance or complete failure due to gas binding.
4. Debris penetration exceeds ex-vessel effects limits causing a variety of potential equipment and component failures due to wear or clogging.
5. Debris penetration exceeds in-vessel effects limits resulting in partial or full core blockage with insufficient flow to cool the core.
6. Buildup of oxides, crud, LOCA-generated debris, and chemical precipitates on fuel cladding exceeds the limits for heat transfer resulting in unacceptably high peak cladding temperatures.

7. Boron concentration in the core exceeds the solubility limit leading to boron precipitation and subsequently resulting in unacceptable flow blockage or impaired heat removal.

Failure Modes 4 and 6 were conservatively addressed as part of the previous deterministic evaluations for STP with no issues of concern and were therefore not explicitly modeled in the PRA analysis. The remaining failure modes are explicitly modeled.

Failure probabilities and associated uncertainties determined in the supporting engineering analysis are passed to the plant-wide PRA, which determines the incremental risk associated with GSI-191 failure modes. The PRA assessment model includes the following events to accommodate composite GSI-191 failure processes:

1. Failure at the sump strainer
2. Boron precipitation in the core
3. Blockage of the core

The engineering analysis supports the three composite failure probabilities needed for the PRA by testing the outcome of postulated break scenarios against seven performance thresholds:

1. Strainer DP ≥ NPSH margin
2. Strainer DP ≥ P-buckle
3. Strainer F-void ≥ 0.02
4. Core fiber load ≥ cold leg break fiber limit for boron precipitation
5. Core fiber load ≥ hot leg break fiber limit for boron precipitation
6. Core fiber load ≥ cold leg break fiber limit for flow blockage
7. Core fiber load ≥ hot leg break fiber limit for flow blockage

P-buckle is the strainer structural design limit for the differential pressure (DP) across the ECCS strainers at which they are analyzed to be within code design allowable stresses. F-void is the vapor fraction of the liquid just downstream of the ECCS strainers.

Using the inputs noted above, the PRA assessment model is informed with risk insights for the failure modes associated with GSI-191 concerns. The PRA analysis yields results that are less than the threshold for Region III, "Very Small Changes," as defined by RG 1.174 (i.e., the change in CDF is less than 1E-6/yr and the change in LERF is less than 1E-7/yr).

On the basis that sump performance is determined acceptable by the risk-informed method, the assumptions in the ECCS evaluation model are valid and the long term cooling licensing basis for compliance with 10 CFR 50.46 is reconstituted, thus resolving GSI-191. Acceptable sump performance in support of ECCS and CSS design requirements in recirculation mode following postulated LOCAs also reconstitutes the licensing basis to meet GDC 35, 38, and 41.

EVALUATING IMPACTS

For the purpose of monitoring future facility changes or other conditions that may impact the PRA results associated with GSI-191, appropriate changes to the as-built, as-operated plant are reflected in updates to the STP at-power PRA reference model. The STP PRA Program is a living program and, as such, is subject to periodic review and updates. These PRA model periodic updates are performed in accordance with STP procedures. The effect of changes to

the at-power PRA Reference model are assessed to ensure impacts to GSI-191 PRA results are evaluated against the criteria in RG 1.174, and any significant findings or conclusions are identified, documented, and entered into the Corrective Action Program as appropriate.
The table below identifies contributors to debris loading that may be discovered in containment during power operation. The table provides the values used as input parameters in the risk-informed engineering analysis and minimum margin represented in the values based on the analysis and engineering judgment (see Reference 6A-4).

The table provides guidance that may be used to immediately assess the potential impact due to unexpected material discovered in containment that may contribute to debris loading on the strainers. As discussed in Reference 6A-4, these values are not necessarily the limiting amount of each type as analyzed. Conservatisms in the reported values are also discussed in Reference 6A-2. Therefore, a condition that may exceed the values shown in the table does not preclude reasonable expectation of operability.

Debris Type	**Input Parameter Value (Reference 6A-6)**	**Minimum Margin**
Latent debris, consisting of: • Dirt and/or dust • Fiber, e.g., fibrous insulation	200 lbm (Total) 170 lbm (1.0 cubic ft) 30 lbm (12.5 cubic ft)	40 lbm (Total) 34 lbm (0.2 cubic ft) 6 lbm (2.5 cubic ft)
Miscellaneous debris, including but not limited to unqualified tags and labels	100 sq-ft	10 sq-ft
Unqualified coatings	Table 6.1-4	100 sq-ft

Due to the complexity of the analysis, the potential exists for conditions to be discovered which may not be represented by the values in the table, and for which evaluations would be required to evaluate the impacts (see References 6A-4 and 6A-5).

REFERENCES

Appendix 6A:

6A-1 Correspondence NOC-AE-05001922, dated August 31, 2005

6A-2 Correspondence NOC-AE-08002372, dated December 11, 2008

6A-3 Regulatory Guide 1.174, "An Approach For Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis" (May 2011)

6A-4 Correspondence NOC-AE-13002986, dated June 19, 2013

6A-5 Correspondence NOC-AE-13003043, dated November 13, 2013

6A-6	STP Risk-Informed GSI-191 Evaluation Volume 3; STP-RIGSI191-V03 Rev. 2 (November 6, 2013)

Attachment 3 to Enclosure 3

Technical Specifications Bases Page Markups

(Information Only)

Technical Specifications Bases Page Markups (Information Only)

Add the following to the end of Bases Section 3/4.5.2 and 3/4.5.3 ECCS Subsystems:

The OPERABILITY of the ECCS Subsystems is assured by the capability of the containment emergency sump to limit entry of high-density particles or floating debris into the sump and recirculating lines. This capability ensures that the flow and net positive suction head requirements of ECCS are satisfied under the most adverse combination of credible occurrence. Assurance that containment debris will not block the sump and render the ECCS Subsystem inoperable on emergency recirculation during design basis accidents is provided by inspection and engineering evaluation. UFSAR Appendix 6A provides a risk-informed approach that addresses the potential of debris blockage concluding that long-term core cooling following a design basis loss of coolant accident is assured with high probability. UFSAR Appendix 6A also provides guidance for assessing the potential impact on Operability due to unexpected material such as loose debris discovered in containment that may contribute to debris loading on the strainers.

Add the following to the end of Bases Section 3/4.6.2.1 Containment Spray System:

The OPERABILITY of the Containment Spray System is assured by the capability of the containment emergency sump to limit entry of high-density particles or floating debris into the sump and recirculating lines. This capability ensures that the flow and net positive suction head requirements of Containment Spray System are satisfied under the most adverse combination of credible occurrence. Assurance that containment debris will not block the sump and render the Containment Spray System inoperable on emergency recirculation during design basis accidents is provided by inspection and engineering evaluation. UFSAR Appendix 6A provides a risk-informed approach that addresses the potential of debris blockage concluding that heat removal capability and atmospheric cleanup capability following a design basis loss of coolant accident are assured with high probability. UFSAR Appendix 6A also provides guidance for assessing the potential impact on Operability due to unexpected material such as loose debris discovered in containment that may contribute to debris loading on the strainers.

ENCLOSURE 4

Risk-Informed Closure of GSI-191

Supporting Engineering Analysis and PRA

Introduction and Overview

Risk-Informed Closure of GSI-191 Supporting Engineering Analysis and PRA – Introduction and Overview

Introduction

Enclosures 4-1, 4-2 and 4-3 provide the engineering evaluation, risk analysis, technical information and references in support of the proposed changes to the STP Units 1 and 2 licensing basis subject to the license amendment request (Enclosure 3) and requested exemptions (Enclosures 2-1 through 2-4).

The structure and content of the supporting information is designed to meet the requirements for risk-informed applications to changes to the licensing bases as specified in RG 1.174.

Overview

Enclosure 4-1, Volume 1 Project Summary

This volume addresses the required content of a RG 1.174 application using the same section numbering scheme as in RG 1.174. This volume summarizes the generic methodology and the plant-specific implementation of the methodology, and discusses how the risk metrics associated with the residual risk of GSI-191 are determined:

- The overall analysis approach describing how engineering analyses are used in a risk-informed framework to support the PRA.
- Identifies where the methods adopted for the STP approach involve deviations from those previously approved for deterministic methods to resolve GSI-191 concerns, primarily NEI 04-07.
- Quantifies the change in risk associated with the concerns raised in GSI-191 in the as-built, as-operated plant (such as fibrous debris beds, chemical effects, in-vessel fiber loads, etc.).

Enclosure 4-2, Volume 2 Probabilistic Risk Analysis

This volume describes the PRA treatment of GSI-191 safety issues and interfaces with deterministic analyses, provides quantification of CDF and LERF risk metrics for comparison to RG 1.174 acceptance guidelines, and provides PRA uncertainty quantification.

Enclosure 4-3, Volume 3 Engineering (CASA Grande) Analysis

Volume 3 is a technical evaluation that provides a high-level description of the phenomenological portion of the overall risk-informed GSI-191 evaluation. This volume provides a detailed summary of supporting engineering analyses (CASA Grande evaluation) including input parameters, assumptions, methodology, analysis and results, and the use of any test results in the analysis. The STP Units 1 & 2 implementation of the generic methodology of the risk-informed approach (Enclosure 1) for addressing the required inputs to the plant-specific PRA model is described.