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U. S. Nuclear Regulatory Commission
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Braidwood Station, Units 1 and 2
Facility Operating License Nos. NPF-72 and NPF-77
NRC Docket No. STN 50-456 and 50-457

Subject: Request for Enforcement Discretion for Technical Specification 3.7.9, "Ultimate Heat Sink"

On July 7, 2012, Exelon Generation Company, LLC (EGC) verbally requested a Notice of Enforcement Discretion (NOED) associated with Technical Specification (TS) 3.7.9, "Ultimate Heat Sink (UHS)," Condition A for Braidwood Station, Units 1 and 2. TS 3.7.9 Condition A requires that with the UHS inoperable, the unit be placed in Mode 3 in 6 hours (Required Action A.1) and Mode 5 in 36 hours (Required Action A.2). The request for Enforcement Discretion was made to avoid an unnecessary plant transient as a result of compliance with TS 3.7.9, Condition A. Therefore, EGC requested an extension of TS 3.7.9 Required Action A.1 Completion Time by 18 additional hours. The enclosed information was discussed with representatives of the NRC on July 7, 2012, at 1630 hours, with subsequent approval being verbally granted by the NRC at 1705 hours.

Prolonged hot weather in the area has resulted in sustained elevated UHS temperatures. High temperatures during the daytime in conjunction with little cooling at night and little precipitation have resulted in elevated water temperatures in Braidwood Station's UHS. There are no controllable measures that can be taken to immediately reduce the temperature of the UHS in that reduction of the heat input by derating the units would have a negligible short-term effect on the temperature of the UHS.

At 1556 on July 7, 2012, the average discharge temperature of the running essential service water pumps exceeded 100 °F. Without enforcement discretion, at 2156 on July 7, 2012, Braidwood Station, Units 1 and 2, would be required to be in Mode 3 in accordance with TS 3.7.9 Required Action A.1. Enforcement discretion was requested to delay entry into Required Action A.1 by 18 additional hours (i.e., change the current 6-hour Completion Time to 24-hours) and to increase the limit on the average water temperature of the UHS in Surveillance Requirement (SR) 3.7.9.2 to 102 °F to allow continued operation of Braidwood Station, Units 1 and 2, with the average water temperature of the UHS $>$ 100 °F but $\leq$ 102 °F for 24 hours. The Enforcement Discretion would end if the average water temperature of the UHS exceeds 102 °F or with the average water temperature of the UHS $<$ 98 °F and on a declining trend.

Approval of the request was verbally granted by the NRC on July 7, 2012 at 1705 hours. EGC is required to submit a written request for the NOED within two working days of the NRC verbal approval. The attached enclosure provides the information documenting EGC's earlier verbal request. There are no regulatory commitments contained in this letter. Should you have any questions or comments regarding this matter, please contact Scott Butler, Acting Regulatory Assurance Manager, at (815) 417-2830.

Respectfully,

Daniel J. Enright
Site vice President
Braidwood Station

Enclosure: Request for Enforcement Discretion for Technical Specification (TS) 3.7.9, "Ultimate Heat Sink"

cc: NRR Project Manager – Braidwood Station
Illinois Emergency Management Agency – Division of Nuclear Safety
US NRC Regional Administrator, Region III
US NRC Senior Resident Inspector (Braidwood Station)
Illinois Emergency Management Agency - Braidwood Representative

ENCLOSURE

Braidwood Station, Units 1 and 2

Docket Nos. STN 50-456 and 50-457

Facility Operating License Nos. NPF-72 and NPF-77

Request for Enforcement Discretion for Technical Specification 3.7.9 "Ultimate Heat Sink"

Request for Enforcement Discretion for
Technical Specification 3.7.9 "Ultimate Heat Sink"

1 The TS or other license condition that will be violated.

Exelon Generation Company, LLC, Braidwood Station, Units 1 and 2, is requesting enforcement discretion for Technical Specification (TS) 3.7.9, "Ultimate Heat Sink (UHS)", Condition A for Braidwood Station, Units 1 and 2. TS 3.7.9 Condition A requires that with the UHS inoperable, the unit be placed in Mode 3 in 6 hours (Required Action A.1) and Mode 5 in 36 hours (Required Action A.2). Surveillance Requirement (SR) 3.7.9.2 verifies that the average water temperature of the UHS is $\leq$100 °F every 24 hours. This temperature is measured at the discharge of the operating Essential Service Water (SX) system pumps. With the average water temperature of the UHS >100 °F, the UHS must be declared inoperable in accordance with Condition A. With the UHS inoperable, Condition A requires that both units be placed in Mode 3, "Hot Standby," within 6 hours and Mode 5, "Cold Shutdown," within 36 hours.

The basis of this TS requirement is that the UHS provides a heat sink for processing and operating heat from safety related components during a transient or accident, as well as during normal operation. This is done by utilizing the SX and the Component Cooling Water (CC) systems.

The UHS consists of an excavated essential cooling pond integral with the main cooling pond, and the piping and valves connecting the pond with the SX system and pumps. The two principal functions of the UHS are the dissipation of residual heat after reactor shutdown, and dissipation of residual heat after an accident.

The basic performance requirements are that a 30-day supply of water be available, and that the design basis temperatures of safety related equipment not be exceeded. The UHS is sufficiently oversized to permit a minimum of 30 days of operation with no makeup.

2 The circumstances surrounding the situation, including likely causes, the need for prompt action, action taken in an attempt to avoid the need for a NOED, and identification of any relevant historical events.

July 4 through July 6, 2012 has brought unprecedented hot weather (tied a record triple-digit streak of three consecutive days from August 1947 and July 1911) and drought conditions to the northern Illinois area resulting in sustained elevated UHS temperatures. High temperatures during the daytime in conjunction with little cooling at night and little precipitation have resulted in elevated water temperatures in Braidwood Station's UHS. There are no controllable measures that can be taken to immediately reduce the temperature of the UHS, in that reduction of the heat input by derating the units would have a negligible short-term effect on the temperature of the UHS.

At 1556 on July 7, 2012, the average discharge temperature of the running essential service water pumps exceeded 100 °F. TS 3.7.9, "Ultimate Heat Sink (UHS)," Condition A was entered. Without enforcement and discretion, at 2156 on July 7, 2012, Braidwood Station, Units 1 and 2, would be required to be in Mode 3 in accordance with TS 3.7.9,

Condition A, Required Action A.1. An extension of the Completion Time of TS 3.7.9 Required Action A.1 by 18 additional hours is requested to delay entry into Mode 3 for both units. In addition, an increase in the limit of the average water temperature of the UHS in SR 3.7.9.2 to 102 °F is requested to allow continued operation of Braidwood Station, Units 1 and 2, with the average water temperature of the UHS > 100 °F but ≤ 102 °F for 24 hours. The station employs a cooling pond temperature prediction computer model to estimate future cooling pond (UHS) temperature based on current local weather forecasts. On Saturday July 7, 2012 at 0600, the model made the first prediction indicating that the cooling pond would exceed 100 °F although the Station had been monitoring pond temperature for more than a month.

Current weather forecasts and lake modeling indicate the UHS temperature excursion above 100 °F will end prior to midnight Saturday July 7, 2012 due primarily to environmental temperature moderating to the mid 80 °F and an increase in local wind. An additional 18 hours is requested to account for the unpredictability of the weather and to ensure the lake cools sufficiently below 100 °F.

3 Information to show that the cause and proposed path to resolve the situation are understood by the licensee, such that there is a high probability that planned actions to resolve the situation can be completed within the proposed NOED timeframe.

Prolonged hot weather in the area has resulted in sustained elevated UHS temperatures. High temperatures during the daytime in conjunction with little cooling at night and little precipitation have resulted in elevated water temperatures in Braidwood Station's UHS.

The EGC lake model output shows that UHS temperature will be ≤ 100°F by the morning of July 8, 2012.

Attachment 2 shows historical and actual lake temperatures (i.e., circulating water temperature) for Braidwood Station. The chart shows the average lake temperature over a 10-year period from 2001 through 2011 (indicated in grey). In addition, the average lake temperature for 2012 is provided (indicated in blue).

4 The safety basis for the request, including an evaluation of the safety significance and potential consequences of the proposed course of action. The following information should be provided in support of this evaluation:

a. Use the zero maintenance PRA model to establish the plant's baseline risk and the estimated risk increase associated with the period of enforcement discretion.

   This evaluation used qualitative methods to address the risk impact. This assessment, though qualitative, did follow the same perspective as would be provided by the use of a quantitative method using the zero-maintenance PRA model. Based on an equipment assessment, there is no impact to equipment capability (see Attachment 1, "Engineering Assessment of Equipment Capability To Support Section 4a"), and therefore, is no increase in risk for the duration of the NOED condition.

b. Discuss the dominant risk contributors (cut sets/ sequences) and summarize the risk insights for the plant-specific configuration the plant intends to operate in during the period of enforcement discretion.

The increase in UHS temperature does not result in an impact to equipment capability. Therefore, there is no change in the dominant risk contributors from the base PRA model results. From a defense-in-depth review, elevated UHS temperatures will impact the cooling efficiency of the main condenser and therefore reduce the margin (time) to respond to a Loss of Condenser initiating event. Compensatory actions, in the form of maintenance limitations are provided in item c. below which includes protecting the Steam Jet Air Ejectors (SJAE) and Main Condenser Vacuum Hogging Pumps. There are 2 skids of SJAE, each with 2 ejector trains and a dedicated hogging pump with a swing hogging pump that can be aligned to either Unit.

c. Explain compensatory measures that will be taken to reduce the risk associated with the specified configuration. Compensatory measures to reduce plant vulnerabilities should focus on both event mitigation and initiating event likelihood.

• Equipment that will remain removed from service are as follows:
  - Auxiliary Building Exhaust Fan, 0VA02CA
  - Auxiliary Building Ventilation Damper, 0VA305Y
  - Unit 1 Station Air Compressor, 1SA01C

With the exception of the above listed equipment, no additional equipment included in the Station Configuration Risk Management Program will be removed from service for planned maintenance activities until the NOED condition is exited.

• No switchyard work beyond that necessary to clear any emergent faulted.

• The following systems will be protected in accordance with WC-AA-101, “On-line Work Control Process” and OP-AA-108-117, “Protected Equipment Program” to limit the impact to Unit operation following a loss of condenser initiating event:

- o Circulating Water pumps and flowpath
- o Condenser Air Removal (SJAEs and vacuum hogging pumps)
- o Support systems for the above (power, cooling controls)

In addition, the following protected equipment is already protected or will be protected to maintain defense in depth and will remain so for the duration of the NOED.

- o Line 0103, 0104
- o 1A VP chiller
- o 2B VB chiller
- o Unit 1 & 2 Spent Fuel Pool Cooling
- o All SX pumps and flowpaths
- o All CC pumps and flowpaths
- o All AF Pumps and flowpaths

• Ventilation equipment, with the exception of 0VA02CA and 0VA305Y (which are already OOS), will remain available.

• Operational risk activities on both units will not be allowed during the duration of the NOED condition. Two Auxiliary Feedwater surveillances are due to be performed during the NOED period; the monthly Under Voltage Simulated Start of 1A and 2A AF pumps. These surveillances must be performed prior to exceeding the surveillance critical date. These surveillances were specifically evaluated by the PRA specialist to not cause the pumps to become unavailable and are not operational risk activities. Therefore, these surveillances can be performed during the NOED period without invalidating the PRA analysis.

• SX pump discharge temperatures will be monitored every hour on each running SX pump locally using precision temperature instrumentation. This will be controlled via Operating Standing Order.

• Unit 2 Refueling Water Storage Tank (RWST) water temperature will be monitored every six hours to ensure it remains $\leq$ 95 °F via Operating Standing Order.

• Both Chemical and Volume Control letdown heat exchangers will be online on each unit.

d. Discuss how the proposed compensatory measures are accounted for in the PRA.

This evaluation is based on a qualitative assessment of the impact of elevated UHS temperature condition for Braidwood station. The compensatory measures identified above limit the maintenance configuration to that identified in section c. (above) and highlight the importance of other systems / functions that should remain available. In addition to the limitations on equipment unavailability, no activities which have a potential for inducing a plant transient will be allowed for the duration of the NOED condition. There was no special accounting for the implementation of the compensatory measures in the qualitative assessment.

e. Discuss the extent of condition of the failed or unavailable component(s) to other trains/divisions of equipment and what adjustments, if any, to the related PRA common cause factors have been made to account for potential increases in their failure probabilities.

The UHS is not failed or unavailable. The additional 2 °F does not increase the potential for an UHS failure. This NOED is requested for a limited period of time to exceed a temperature limit associated with the Ultimate Heat Sink. As there is no impact from the elevated UHS temperature up to a limit of 102 °F, there were no considerations of changes to common-cause factors for this assessment.

f. Discuss external event risks for the specified plan configuration.

The external event impacts under an elevated UHS temperature condition include fire, seismic, external flooding, severe weather, high winds and tornadoes. Based on no impact to equipment capability up to an UHS temperature of 102 °F, the elevated UHS temperature condition has no direct impact on the likelihood of a fire initiating event or on the ability to mitigate the impact of the fire event. A similar conclusion

can be drawn for seismic and other external events such as external flooding, severe weather, high winds and tornadoes.

g. Discuss forecasted weather conditions for the NOED period and any plant vulnerabilities related to weather conditions.

   July 7, 2012 – Saturday: 20 percent chance of showers and thunderstorms after 1pm. Mostly sunny and hot, with a high near 101 deg F. Heat index values as high as 108 deg F. Southwest wind 5 to 10 mph becoming west northwest in the afternoon.

   July 7, 2012 - Saturday Night: 20 percent chance of showers and thunderstorms. Partly cloudy, with a low around 71 deg F. Northeast wind 10 to 15 mph.

   July 8, 2012 – Sunday: 20 percent chance of showers and thunderstorms. Partly sunny, with a high near 82 deg F. North northeast wind 10 to 15 mph with gusts as high as 25 mph.

   July 8, 2012 - Sunday Night: Partly cloudy, with a low around 64 deg F. North northeast wind 5 to 10 mph becoming light after midnight.

   There are no additional plant vulnerabilities related to the weather conditions for the duration of the NOED.

In addition, Nuclear Oversight will implement oversight of the NOED activities.

5 The justification for the duration of the noncompliance.

We have determined that there is a minimal safety consequence of extending the Completion Time of Required Action A.1 by an additional 18 hours and increasing the average water temperature of the UHS from ≤ 100 °F to ≤ 102 °F. It was determined that a 2 °F increase in UHS temperature has either no impact or an insignificant impact on the LOCA and non-LOCA results. Additionally, component assessments were performed and determined that components served by UHS would continue to perform satisfactorily despite a 2 °F increase in UHS temperature. No adverse influences on risk were identified through examination of the PRA model for the plant. Enforcement discretion is requested to extend the Completion Time of Required Action A.1 by an additional 18 hours and temporarily increase the limit on the average water temperature of the UHS for a period not to exceed 24 hours since the overall hot weather period is expected to subside within 24 hours. Furthermore, despite the current hot weather conditions, the average water temperature of the UHS is only expected to exceed 100 °F and remain within the revised limit for less than a day.

6 The condition and operational status of the plant (including safety-related equipment out of service or otherwise inoperable).

Braidwood Station Units 1 and 2 are currently operating in Mode 1 (Power Operations) at approximately 100% reactor power. On-line risk is green. There are no clearance orders or surveillances that are in progress that affect safety system operability. Equipment that

will remain removed from service for planned maintenance are: Auxiliary Building Exhaust Fan, 0VA02CA, Auxiliary Building Ventilation Damper, 0VA305Y, and Unit 1 Station Air Compressor 1SA01C

7 The status and potential challenges to off-site and on-site power sources.

All off-site and on-site power sources are currently operable with no expected outages for the duration of the NOED.

All Emergency Diesel Generators are within their surveillance testing frequency and we have verified grid/offsite power status with the transmission system operator.

8 The basis for the licensee's conclusion that the noncompliance will not be of potential detriment to the public health.

For the limiting accidents analyzed, the 2 °F increase in UHS temperature resulted in no adverse increase in Peak Clad Temperature (PCT) or in containment peak pressure. As a result, containment leakage and off site dose remains bounded by the existing design basis analyses using current available margins. Therefore, there is no increased risk to the health and safety of the public.

9 The basis for the licensee's conclusion that the noncompliance will not involve adverse consequences to the environment.

Although the proposed action involves noncompliance with the requirements of an LCO:

(i) There is no significant change in the types or a significant increase in the amounts of any effluent that may be released offsite, since the proposed actions neither affect the generation of any radioactive effluent nor do they affect any of the permitted release paths; and

(ii) There is no significant increase in individual or cumulative occupational radiation exposure. The actions proposed in this request for Enforcement Discretion will not significantly affect plant radiation levels, and therefore do not significantly affect dose rates and occupational exposure.

The UHS is part of a larger cooling pond. Per the Exelon Reportability Manual under reporting item ENV 3.26, Cooling ponds are thermal treatment units and, therefore, are not part of the environment. As a result, no adverse consequences to the environment will occur.

10 A statement that the request has been approved by the facility organization that normally reviews safety issues (Plant Onsite Review Committee, or its equivalent).

The request for enforcement discretion has been approved by the Braidwood Station Plant Operations Review Committee (PORC) to meet the requirements of the Braidwood Station administrative procedures.

11 The request must specifically address which of the NOED criteria for appropriate plant conditions specified in Section B (of Inspection Manual Part 9900) is satisfied and how it is satisfied.

The requested enforcement discretion has been evaluated against the criteria specified in Section B of Inspection Manual Part 9900. We have determined that the requested actions meet the NOED criteria for an operating plant. This determination is based on the avoidance of an undesirable transient caused by the shutdown of the reactor as a result of forcing compliance with the Technical Specifications and, thus, minimizes potential safety consequences and operational risks associated with a plant shutdown.

There is no net increase in radiological risk to the public.

12 Unless otherwise agreed as discussed in Section B, a commitment is required from the licensee that the written NOED request will be submitted within 2 working days and the follow-up amendment will be submitted within 4 working days of verbally granting the NOED. The licensee's amendment request must describe and justify the exigent circumstances (see 10 CFR 50.91(a)(6)). The licensee should state if staff has agreed during the teleconference that a follow-up amendment is not needed. If the licensee intends to propose a temporary amendment, the licensee's amendment request shall include justification for the temporary nature of the requested amendment.

EGC will provide a written NOED request within two working days.

The conditions requiring the requested NOED are not typical and have not occurred in the past twelve years since a license amendment was implemented to increase UHS temperature to 100 °F.

Currently available equipment margins and in one case operational compensatory actions were required to support the increase to 102°F. Imposing these reduced margins and operational compensatory actions as design basis conditions is not supportive of maintaining operational margins. Thus, a License Amendment Request will not be submitted. The need for a License Amendment Request was discussed with the NRC during the teleconference, and the NRC agreed that a follow-up amendment is not needed.

13 In addition to items 1-12 above, for a severe-weather NOED request, the licensee must provide the following information:

This NOED request is not severe-weather related.

Relief is requested to extend the Completion Time of Required Action A.1 by an additional 18 hours and increase the 100 °F UHS temperature limit specified in SR 3.7.9.2. Braidwood Station, Units 1 and 2, are currently operating in Mode 1, "Power Operation." A 2 °F increase to the SR limit is proposed for a period of 24 hours to allow the temperature of the UHS to be returned to within limits and allow SR 3.7.9.2 to be met.

To ensure the requested temperature limit is not exceeded, instrument uncertainty associated with the measurement of the UHS average water temperature, is addressed in the surveillance used to demonstrate compliance with the TS limit. The surveillance requires that if the temperature of any operating SX pump exceeds 97 °F, a precision temperature instrument procured for this application be used to verify the temperature. The difference between 97 °F and the current SR limit is 3 °F which is greater than the calculated instrument uncertainties associated with the installed instrumentation. Highly accurate measurement can be accomplished by inserting the probe of the precision thermometer into spare thermowells adjacent to the installed instrumentation. The uncertainty of this precision thermometer is no more than 0.07 °F. The temperature limit specified in the surveillance used to demonstrate compliance with the TS limit has been revised to 101.9 °F to account for the uncertainty associated with this instrument.

The UHS is the sink for heat removed from the reactor core following all accidents and anticipated operational occurrences in which the unit is cooled down and placed on Residual Heat Removal (RHR) operation. The operating limits are based on conservative heat transfer analyses for the worst case loss of coolant accident (LOCA). The UHS is designed in accordance with Regulatory Guide (RG) 1.27, "Ultimate Heat Sink for Nuclear Power Plants," Revision 2.

From UFSAR Section 9.2.5.1:

The maximum heat load on the UHS consists of one unit undergoing post-LOCA cooldown concurrent with a LOOP, and the unaffected unit undergoing a safe non-accident shutdown. Both units are assumed to be at full power operation prior to the shutdown. The main cooling pond is assumed to be unavailable at the beginning of the accident. Only the UHS is assumed to be available. The UHS is the source of water for the ESW pumps to cooldown the plant.

The current design basis analyses support an SX temperature of 100 °F. Further evaluations of the impact of a 2 °F increase in SX temperature on accident analyses and containment response and assessments of the components served by SX have been performed. The evaluations and assessments demonstrate that there is no increase in risk as a result of the proposed temperature increase and are discussed below.

Impact on Accident Analyses

The current Technical Specification Surveillance Requirement (SR) 3.7.9.2 verifies that the average water temperature of the ultimate heat sink (UHS) is ≤ 100°F as measured at the discharge of the operating essential service water (SX) pumps. The current analysis of record for Braidwood Units 1 and 2 were reviewed and it was concluded that a 2°F increase in the UHS water temperature (from 100 °F to 102 °F) will have no or minimal impact on the large break loss of coolant accident (LBLOCA), small break loss of coolant (SBLOCA), long term core cooling (LTC) and non-LOCA analyses.

The minimum or the maximum SX temperature is not explicitly modeled in the 10CFR 50.46 LOCA analysis or the non-LOCA safety analyses. Also, the minimum or the maximum temperature of the component cooling (CC) water is not explicitly modeled in the LOCA or the non-LOCA safety analyses.

However, the LOCA analyses (and some non-LOCA transients) assume the minimum and/or the maximum water temperature of the Emergency Core Cooling System (ECCS) and the maximum cooling capacity of the reactor containment fan coolers (RCFC). Both of these assumptions can be potentially impacted by the assumption of the SX temperature. These impacts are addressed below.

Large Break LOCA

In the event of a LBLOCA, the ECCS water is initially drawn from the refueling water storage tank (RWST). When the RWST empties (or nearly empties) the pumps are realigned to the Containment sump, i.e., cold leg recirculation. Assuming no single failure and full runout flow from all the pumps, the earliest time the RWST can empty is in excess of ten minutes.

The current licensing basis peak clad temperature (PCT) is 1957 °F for Unit 1 and 1999 °F for Unit 2. These PCTs include the impact of thermal conductivity degradation (TCD). A review of the results of the current analysis indicates that PCT occurs by 500 seconds. Therefore, the transient is over while the ECCS water is drawing suction from the RWST. Since SX temperature has no effect on the RWST water temperature, an increase in SX temperature of 2 °F will have no impact on the outcome of the PCT.

During the long term, when the ECCS water is drawing suction from the sump, the SX temperature can have an effect on the peak clad temperatures. However, at this point in the transient, the peak clad temperatures are significantly lower, and a 2 °F variance in SX temperature will not have a significant impact on the results.

Furthermore, it is conservative to minimize the containment pressure when evaluating overall ECCS performance as described in NUREG-0800, Section 6.2.1.5, "Minimum Containment Pressure Analysis for Emergency Core Cooling System Performance Capability Studies." Lower containment pressure results in a lower reflood rate and hence a higher PCT. To minimize containment pressure, maximum RCFC heat removal capacity is assumed in the LBLOCA analysis. Consequently, the heat removal capacity of the RCFCs was calculated based on an SX temperature of 32 °F (UFSAR, Table 6.2-54). Therefore, the higher SX temperature is not applicable.

The impact of the UHS temperature increase on the ECCS pumps is discussed in subsequent sections.

Based on the above, an increase in SX temperature of 2 °F will have little or no detrimental impact on the outcome of the LBLOCA PCT.

Small Break LOCA (SBLOCA)

In the event of a SBLOCA, the ECCS water is initially drawn from the RWST. When the RWST empties (or nearly empties) the pumps are realigned to draw suction from the ECCS recirculation sump, i.e., cold leg recirculation. In the SBLOCA analysis during cold leg recirculation, the ECCS water temperature discharged to the Reactor Coolant System (RCS) is assumed to be at 212°F. That is, there is basically no (if one assumes the containment pressure to be 14.7 psia) or little credit taken for the cooling of the ECCS water by the RHR heat exchangers.

Furthermore, there are a number of conservative assumptions applied in the SBLOCA analysis. The following lists a few examples:

- 1971 ANS decay heat with an additional 20% is assumed in the analysis.
- Conservative ECCS flows are assumed in the analysis, i.e., the ECCS pumps are assumed to be significantly degraded.
- All the neutronic parameters (such as power shapes, axial offset, etc.) are assumed to be in the worst conditions at the same time.
- The most limiting fuel parameters, i.e., stored energy, are assumed in the analysis.

The impact of the UHS temperature increase on the ECCS pumps is discussed in subsequent sections.

Based on the above, a 2 °F increase in SX temperature will have no detrimental impact on the outcome of the SBLOCA PCT.

<u>Hot Leg Switchover (HLSO) Analysis</u>

To preclude boron from precipitating in the core and to ensure long term core cooling, hot leg switchover (HLSO) analysis is performed. The current HLSO analysis assumes that the hot leg recirculation is initiated 6 hours after the LOCA inception and no safety injection sub-cooling is assumed (UFSAR 6.3.2.5). Additionally the HLSO analysis contains the following conservatisms:

- A boron precipitation limit of 24 wt% is assumed in the analysis. In reality, boron precipitation is 28 wt% at 14.7 psia. This represents a 4 wt% conservatism.
- No credit for the baffle/barrel region volume is assumed in the analysis. There are flow paths between the baffle/barrel region and the core. This volume could be credited.
- No nozzle gap leakage was assumed in the analysis. In reality, there will be leakage from the nozzle gaps.

Based on the above, a 2 °F increase in SX temperature will have an insignificant impact on the HLSO analysis.

<u>Non-LOCA Analyses</u>

For three non-LOCA events, main steam line break (MSLB), feed line break (FLB) and steam generator tube rupture (SGTR), the ECCS is modeled and assumed to operate. For these events the transient is terminated well before the RWST is drained down since

only the charging and the safety injection pumps actuate during these events. Therefore, a 2 °F increase in SX temperature will have no detrimental impact on the outcome of the MSLB and the SGTR results.

The following summarizes the assessments of the components served by Essential Service (SX) water.

1. CC System

CC System Normal Operation

The main components served by the CC System during normal plant operation include the Letdown heat exchangers, Reactor Coolant Pumps (RCP) Thermal Barriers, RCP Motor Bearing Oil Coolers, Seal Water heat exchangers, Spent Fuel Pool (SFP) heat exchangers, and Containment Penetration Cooling. The design maximum cooling water supply for the Waste Gas compressor is 110 °F; this bounds the maximum CC temperature of 107 °F.

The CC Heat Exchanger outlet temperature is normally limited to 105°F during 100% power operation and 120°F after initiation of RHR for a normal RCS cooldown. Plant Emergency Operating Procedures direct actions to maintain the CC heat exchanger outlet temperature below 120 °F during post-accident conditions. During ECCS Recirculation, CC flow is supplied to the RHR pump seal cooler. Westinghouse documentation shows that a CC temperature up to 130 °F does not degrade the operation of the seal cooler and, thus, does not impact the operation of the RHR pump. Assuming the SX temperature increase of 2°F causes the CC temperature to increase to 122 °F, the resulting temperature is bounded.

If the SX temperature were assumed to be increased to 102°F and no other evaluation inputs were adjusted, then during normal operation, the CC Heat Exchanger outlet temperature could potentially increase from 105°F to approximately 107°F.

Provided below is a discussion of the potential impacts if the CC Heat Exchanger outlet temperature were assumed to increase to 107°F, however, recent operating experience with the UHS approaching 100F indicates that exceeding the operating limit of 105°F can be avoided based on current throttle valve position and available SX flow.

(a) Based on the available temperature differences between the CV and CC flows at the Letdown Heat Exchangers, an assumed 2 °F increase in the CC supply temperature would not have any significant impact in the heat exchanger performance. Typically, during warm weather conditions, two letdown heat exchangers are put in service; therefore, flows can be adjusted to compensate for the higher CC temperatures.

(b) The RCP thermal barrier provides back up RCP seal cooling in the unlikely event of a loss of seal injection. Seal injection is provided by one of two safety related centrifugal charging pumps, each capable of being powered from an emergency standby diesel generator. A postulated increase in CC temperature from 105°F to 107°F would still meet the RCP thermal barrier CC inlet temperature normal

operation limit of 120°F. Operation above 120°F is not expected since the largest heat load on the CC system occurs following a LBLOCA but the RCPs are shutdown and CC is isolated to containment during this accident. Other accident scenarios do not place a large heat load on the CC system and are actually similar to a normal shutdown. It is expected that Operating could control CC temperature with adjustments to SX flow and the cooldown rate such that a CC temperature of 120°F is not exceeded.

(c) RCP motor bearing temperatures during normal plant operation (i.e., approximately 130°F to 165°F) are significantly below the operational limit of 195°F. An increase in CC temperature of 2°F would continue to maintain these temperatures significantly below operational limits.

(d) The Seal Water heat exchanger cools the RCP seal return flow (about 12 gpm). The discharge flow from the Seal Water heat exchanger is routed to the outlet of the Volume Control Tank. At this point, this water mixes with the balance of the charging flow, i.e., letdown and makeup, and enters the suction header to the Charging (CV) pumps. Considering the magnitudes of the seal water flow and the balance of the charging flow, a temporary 2°F increase in seal water temperature would not have a significant impact on the temperature of the water supply to the CV pumps and ultimately the RCP seals.

(e) The limiting SFP heat load is experienced during a refueling outage while the reactor fuel assemblies are offloaded. During normal operation, the impact of a temporary CC temperature increase of 2°F on the SFP temperature is bounded by the design basis analyses. The Technical Requirements Manual requirement for in-core decay time (ICDT) ensures that the SFP temperature remains bounded by the design basis analyses. The maximum SFP temperature is dependent on several parameters, i.e., the number of fuel assemblies in the SFP, the ICDT of the fuel assembles prior to starting the core offload, the offload rate, the CC temperature, etc. If a change to a parameter is needed, an evaluation is performed. The evaluation ensures that acceptable SFP temperatures and heat loads are maintained. SFP time to boil would decrease by no more than 22 minutes from a nominal time to boil of 16 hours.

(f) CC water is supplied to the cooling coils in a number of mechanical containment penetrations that serve high energy piping (i.e., Main Steam, Main Feedwater, etc.) The function of the cooling coils is to maintain the temperature of the concrete within these penetrations. A worst case temporary increase in concrete temperature of 2°F would not have an impact on the concrete short term or long term degradation.

(g) The CC System also supplies cooling to the shell side of the seal cooler for each RHR pump. A temporary increase of 2°F in the seal water temperature would not have an impact on the RHR pumps' mechanical seals. Westinghouse documentation shows that a CC temperature up to 130 °F does not degrade the operation of the seal cooler and, thus, does not impact the operation of the RHR pump.

2. Emergency Diesel Generator (EDG)

The existing EDG Jacket Water Heat Exchanger analysis is based on an SX temperature of 100°F, a heat load of 12.2 MBTU/hr (110% DG capacity), and an assumption that 54 of the heat exchanger tubes have been plugged. An assessment was performed assuming SX temperature at 102°F and conservative tube plugging of 9% (30 tubes compared to a maximum actual of 16 tubes); the calculated Jacket Water temperature of 173 °F is significantly below the jacket water high temperature alarm of 205°F. Based on the margin available due to the conservative heat load assumption, the EDG Jacket Water Heat Exchanger has adequate capability to transfer the actual heat load with an SX inlet temperature of 102°F.

3. Auxiliary Feedwater Pump.

The SX System cools the diesel driven AF pump closed cycle heat exchanger and is also the safety related suction supply for the AF pumps.

(a) The diesel driven AF pump closed cycle heat exchanger was specified and designed for a maximum SX cooling water temperature of 102°F and, therefore, no additional evaluation is required.

(b) SX is the safety related suction supply to the AF System. Accident analyses included in UFSAR chapter 15 assume AF enthalpy to be at least 91.12 Btu/lb_m. Conservatively assuming a discharge pressure of 1875 psia for the AF pump, water temperature under those conditions would be 118.4°F. Taking into consideration that temperature rise across the AF and SX pumps is approximately 4°F, an SX temperature of 102°F is bounded by the existing accident analyses assumptions for AF temperature.

(c) The Net Positive Suction Head Required (NPSHR) for the AF pump is 23 ft at 1000 gpm according to the pump performance vendor curve . The Net Positive Suction Head Available (NPSHA) is defined as: Absolute head at the pump suction minus vapor pressure head in feet of water at the temperature of interest. The AF pump suction pressure is conservatively assumed as 75 psia (field observation) which is equivalent to 174.2 ft of water and the vapor pressure is 1.008 psia or 2.34 ft of water at 102 °F. Therefore, the NPSHA is much larger than the NPSHR and an increase in SX temperature to 102°F has no degrading impact on the calculated $NPSH_{available}$ for the AF pump.

4. Essential Service (SX) pumps.

The increase in SX temperature from 100°F to 102°F results in a reduction in $NPSH_{available}$ of < 0.2 ft. This reduction is insignificant as the available margin between $NPSH_{required}$ and $NPSH_{available}$ is in excess of 7 ft.

5. Main Control Room (MCR) Chillers.

A review of the design analysis for the MCR Chillers indicates that the required chiller capacity is approximately 79% of the MCR Chiller's rated capacity. In addition, the original chiller capacity testing demonstrated that the MCR chillers were capable of producing their full rated capacity with an SX inlet temperature of 105°F. Therefore, an

increase in the SX inlet temperature from 100°F to 102°F would not have an adverse impact on the ability of the MCR chillers to provide the required cooling.

6. Cubicle Coolers, Lube Oil Coolers, and other ECCS support equipment.

It may be conservatively assumed that an increase in SX temperature of 2°F could result in an increase in the equipment operating temperatures by as much as 2°F.

(a) Cubicle cooler performance could be slightly impacted, so as to result in a temporary increase of 2°F to environmentally qualified equipment operating environments. The Braidwood Environmental Qualification (EQ) Program conservatively assumes the maximum continuous area temperature for the normal operating environment when calculating the qualified life of safety-related equipment. The TRM imposes administrative limits on area temperatures, so as to ensure that the basis for EQ remains valid. The existing design basis calculations for the cubicle coolers are based on an SX temperature of 100°F. Due to the diurnal nature of the SX temperature profile and considering an a peak SX temperature of 102°F, it is not expected that the normal environmental area temperature monitoring limits specified in the TRM will be exceeded. Furthermore, the TRM does not require immediate action to be taken unless the temperature in the area is exceeded for greater than 8 hours or by greater than 30°F. Small increases of up to 2°F in each of the affected rooms will not impact the qualified life of the equipment.

(b) For components cooled directly by SX (e.g., lube oil coolers), sufficient margin exists with oil and bearing temperatures to support a short duration (< 24 hours) increase in temperatures as a result of a 2 °F increase in UHS temperature. In general, these temperatures are checked and monitored during quarterly surveillances which include summer time conditions with elevated UHS temperatures. These demonstrate operability of the equipment as a whole, i.e. bearings, lubricant, seals, and terminations, inclusive of ancillary devices, at higher temperatures. A 2°F increase in lube oil temperatures would have an insignificant effect on oil properties and would not impact the operation of the affected equipment.

(c) During accident cooling, UHS temperature slowly decreases. The higher initial temperature of 102 °F will not result in excessive inventory loss in the event of an accident during the 30 day period following the accident. Currently there exists an average 2.76" of added depth to the UHS which represents inventory margin that exceeds (engineering judgment) the expected additional evaporation that would occur with a 2 degree higher starting temperature.

Open Operability Evaluations

Operability Evaluation 11-007

This evaluation addresses the fact that the original analyses for GL 96-06 were not updated with the revised containment temperature response following power uprate during the 2001-2002 timeframe.

The 96-06 analyses deal with waterhammer and isolated piping pressurization.

Waterhammer

The waterhammer analysis covers the time prior to re-establishing SX flow following a LOOP and LOCA or MSLB. During this time, heat transfer from the containment atmosphere to the RCFC coils has the potential to create steam voids in the coils. As a result of the 2 °F increase of the SX water temperature, the void formation characteristics will remain essentially the same. Therefore, an increase in SX temperature does not impact the results of the analysis and the conclusions of the operability evaluation.

Isolated Piping Pressurization

The operability evaluation discusses containment penetrations that have been dispositioned with analytical methods. These are penetrations P-37 (CV System), P-55 (SI system), P-70 (PS System) and P-71 (CV System). Penetrations P-55 and P-70 are limited by the temperature profile from the MSLB event. The 2 °F SX temperature increase has an insignificant impact on the MSLB temperature profile and thus, does not impact the conclusions of the Operability Evaluation. Penetration P-37 has a minimum margin of 10% between the calculated and allowable internal piping pressure. The 10% margin is judged adequate to account for the 2 °F SX temperature increase. Penetration P-71 is isolated by air operated valves on the charging line (1/2CV8324A and 1/2CV8324B). The actuator pre-load for these valves is less than the 5600 psi force to lift the valve plug off its seat. Thus, any increase in containment temperature will not result in a piping pressure greater than 5600 psi. The 2°F SX temperature increase does not change this conclusion.

Operability Evaluation 11-012

Operability Evaluation 11-012 addresses a concern identified related to the performance of the Diesel Driven Auxiliary Feedwater Pump during a Station Blackout Event. Specifically, there are recirculation paths within the Essential Service Water (SX) System that result in the heatup of the water supplied to the Diesel Driven Auxiliary Feedwater Pump cooling equipment for the pump and engine. High temperatures may result in pump or engine failure or an automatic trip.

Operability Evaluation 11-012 conservatively assumed that SX Booster Pump suction temperature would reach a value that would challenge the B AF Pump Jacket Water (JW) high temperature trip setpoint after two system volumes were turned over on recirculation or two time constants. This was based on an initial SX Booster Pump suction temperature of 100 °F.

Based on a system volume of 22,000 gallons and a turn over flow of 689.2 gpm, one time constant is 31.9 minutes. Two time constants is 63.8 minutes. At the end of two time constants the SX Booster Pump suction temperature would be approximately 117.5 °F. This is 3 °F less than the SX Booster Pump suction temperature corresponding to the JW high temperature trip setpoint. An additional margin of 3 °F is included for the temperature switch setting tolerance.

If the initial SX Booster Pump suction temperature is 102 °F the time to reach 117.5 °F is reduced. The final equilibrium temperature after several time constants is also increased by

2 °F. Using an exponential relationship, the time to reach an SX Booster Pump suction temperature of 117.5 °F is approximately 46.5 minutes using the higher starting temperature.

The concern in Operability Evaluation 11-012 is terminated when the SX system is cross-tied between units per the Loss of All AC procedure 1/2BwCA-0.0. This cross-tie will occur within 30 minutes from event initiation. Considering the margins and conservatisms in the analysis and the ability of the operating team to cross-tie the SX System in a timely manner, the conclusions in Operability Evaluation 11-012 remain valid for an initial SX supply temperature of 102 °F.

Other Analyses

Other considerations, such as the impact of increasing the UHS temperature to 102 °F on Generic Letter (GL) 96-06, "Assurance of Equipment Operability And Containment Integrity During Design-Basis Accident Conditions," and Station Blackout (SBO), were also evaluated. Conservatism in existing GL 96-06 analyses is sufficient to offset the increased UHS temperature, i.e., assumptions which maximize the extent of voiding and minimize the time to void collapse. The net effect would be well within the calculational uncertainty inherent in two-phase hydraulic analyses. In the case of SBO, the UHS temperature was not used as a direct input.

In the SBO analysis, SX is cross-tied between the non-blacked-out (NBO) and the blacked-out (BO) units within 30 minutes. The use of a single pump to supply both units' loads during a SBO was shown by flow analysis to be acceptable. Conservatism exists in the required flow value that was established for this analysis, because both trains of RCFCs on the BO unit and one train of RCFC on the NBO unit are assumed to be isolated. The SBO analysis demonstrated acceptable flow values to the required components greater than or equal to minimum flow requirements. The cubicle cooler for the AF Diesel Driven pump room was confirmed to remove the required heat load with an SX temperature of 102 °F. Additionally, the assessments described above have demonstrated that the components served by SX will perform their intended safety functions at the higher SX temperature; therefore, a 2°F increase in SX temperature will not have an impact on the SBO analysis.

Westinghouse Containment Analysis

The containment analysis consists of the Loss of Coolant Accident (LOCA) and Main Steamline Break (MSLB) containment integrity analyses. The LOCA analysis for Unit 1 and Unit 2 were performed for a UHS temperature of 102°F. For Unit 1 the peak containment pressure increased from 41.38 psig to 41.42 psig which are below the containment Pa of 42.80 psig and is therefore acceptable. For Unit 2, the peak containment pressure was already within 0.01 psig of Pa at 38.39 psig compared to a Pa of 38.40 psig. In order to accommodate the 102°F UHS temperature, the upper limit on Refueling Water Storage Tank (RWST) was reduced 5°F which resulted in increased margin. The Unit 2 LOCA peak pressure was 38.29 psig compared to a Pa of 38.40 psig with the reduced RWST temperature. Therefore, Unit 2 LOCA analysis is acceptable with 102°F UHS temperature provided RWST temperature is limited to 95°F. For the MSLB analysis, the current peak pressures are less than 40 psig compared to a design pressure of 50 psig. By inspection, the 2°F increase in UHS temperature will not overcome this large margin. Therefore, the

steamline break containment analysis results will remain acceptable. The new RWST temperature limit of 95°F is a compensatory action in support of the NOED. If Unit 2 RWST exceeds 95F, Operations will take the currently required Technical Specification actions for exceeding UHS maximum temperature.

Conclusion

The safety functions of the equipment impacted by elevated SX and CC temperatures are not adversely affected.

Attachment 2
Historical Circulating Water Temperature
Average 2001 through 2011