NRR-PMDAPEm Resource

From: Wiebe, Joel
Sent: Monday, October 26, 2015 4:05 PM
To: Jessica Krejcie
Subject: Preliminary Balance of Plant RAIs for Braidwood Ultimate Heat Sink LAR

Jessica
The purpose of preliminary RAIs is to ensure the questions are clear and understandable. If a clarification call is necessary let me know within one week of this e-mail. Your response is requested within 30 days of this e-mail or, if a clarification call is necessary, within 30 days of the clarification call.

SBPB RAIs FOR BRAIDWOOD LICENSE AMENDMENT REQUEST FOR TS 3.7.9, "ULTIMATE HEAT SINK"

SBPB RAI-1- Atmospheric heat transfer relationships in licensee model

Background
The licensee states in Section 6.3 of ATD-109 "The initial natural temperature for each case is taken to be the natural temperature of the lake at the time step of the start date of the weather file. The natural lake temperature at these time steps is found in the results of the 'Worst_Weather_110' case from the file 'Worst_Weather_110.pltX'. These natural lake temperatures will be used to set the initial natural lake temperature in the worst weather LAKET-PC runs made in the main body of this calculation."
It also states, "The natural lake temperature refers to the temperature of the lake if it is reacting to purely natural influences. The initial natural lake temperature is the initial temperature of the lake that is not in the participating part of the UHS."

Issue
The initial lake temperature for all the runs as shown in the figures of attachment E is the proposed TS limit of 102°F. Section 6.3 states the natural lake temperature is used to set the initial natural lake temperature in the worst weather LAKET-PC runs made in the main body of this calculation.
The use of natural lake temperature, initial lake temperature at the start of a DBA and the proposed TS limits are not clearly explained in the application.

Regulatory Basis
NUREG-0800, Standard Review Plan, provides guidance to the reviewer to verify that The UHS has the capability to dissipate the maximum possible total heat load by conducting independent check calculations. An understanding of the LAR's analysis is required.

Request
Explain how natural lake temperature is used in LAKET-PC and how it relates to initial lake temperature at the start of the DBA and the proposed TS limit of 102°F
Explain why the natural lake temperature, which is stated to be the temperature of the lake reacting to purely natural influences, is a function of the number of pumps running as stated in Table 6-7?
Clarify how the natural temperature is used in the UHS analysis and how natural lake temperature is used in the heat transfer equations for the LAKET-PC?

SBPB RAI-2 - Hydraulic model(s) for Braidwood UHS pond

Background –
The analysis of UHS thermal performance presented in the LAR portrays the pond as a series of equal-sized segments with water flowing through at a fixed rate, with no mixing laterally, longitudinally or vertically. The licensee calculated the effective area and volume of the UHS pond on the basis of an empirical method that was developed for cooling ponds in general (MAD 83-0239 (Reference 5.1) , "Effective Area of Cooling Lakes", MES11.1, Sargent and Lundy Rev 1A, 11/3/2014). The effective area and volume of the pond is taken as a large fraction (82.3%) of the actual volume and area to account for non-idealized flow and transport of hot water.

Issue – NRC staff needs to determine whether the licensee's plug flow analysis results in a conservative evaluation of peak return temperature, in light of the evidence from review of the LaSalle UHS pond that the hydraulics of the pond may not be well represented by a one-dimensional plug flow with each plug corresponding to 3 hours of pump flow. Evidence of the complex circulation caused by jet discharge can be

found in the CFD analysis done by the licensee for the LaSalle UHS pond. The licensee responded to NRC's Request for Additional Information (RAI) number 5 (Gullot, 2015) with a detailed description of their methodology for estimating effective area and volume. This approach may or may not be conservative and this cannot be determined without further analysis and attention to details of the actual Braidwood UHS pond. For example, based on information in the licensee's application, discharged water would enter the pond through submerged pipes at speeds up to 8.51 ft/sec, depending on the number of SX pumps in operation. Based on an audit conducted at the Braidwood site in July 2015, the NRC staff believes that the water is discharged straight up and above the lake level. The drawings and LAR do not clearly describe how the discharge enters the pond. This discharge could lead to a high rate of vertical and horizontal mixing, and the inducement of significant circulation throughout the pond. Furthermore, irrespective of mixing caused by the jets, the discharged water would result in a wide distribution of travel times between the discharge and intake, caused by the spread of the discharged water to conform to the rectangular shape of the pond rather than a single travel time as portrayed in the plug-flow model. The licensee's analysis recognizes the spread and the distribution of travel times, but their method for determining the effective area and volume may not adequately account for the type of discharge. It also assumes that the velocity profile of flow through the pond varies linearly between zero and twice the average velocity in the center.

Regulatory Basis

NUREG-0800, Standard Review Plan, provides guidance to the reviewer to verify that The UHS has the capability to dissipate the maximum possible total heat load by conducting independent check calculations. An understanding of the LAR's analysis is required.

Request –

Provide any evidence, based on actual measurements of circulation in the UHS pond, model studies, or analogs, on the actual pond hydraulics. Alternatively, perform sensitivity studies with your performance model over a range of effective volumes and surface areas that encompass and exceed the current estimate of 83.2% efficiency. Present your reasoning for why the LAKET-PC model is an accurate or conservative model for the purpose of calculating peak return temperature

SBPB RAI-3 – Raw and processed data on meteorology, heat load, and physical pond measurements

Background –

The LAR does not provide details in most cases of the raw and processed data used in the UHS analyses.

Concern –

Staff needs to verify that meteorological inputs for the analysis, particularly wind speeds, dry bulb and dew point temperatures, are realistic or conservative. This is especially important because the Braidwood site is significantly closer to Lake Michigan than are either Peoria or Springfield. Also, data files on heat loads would be necessary should NRC proceed with a confirmatory analysis of its own.

Regulatory Basis

NUREG-0800, Standard Review Plan, provides guidance to the reviewer to verify that The UHS has the capability to dissipate the maximum possible total heat load under the worst environmental conditions by conducting independent check calculations. The staff needs the meteorological input data.

Request –

Provide (in machine-readable form whenever possible) the following information:

- Onsite meteorological data
- Data from off-site weather stations used in the analyses
- Heat loads and flow rates of plant discharges to the UHS pond
- Detailed pond geometry, including the height of any berms or structures that could impact wind speed over the water's surface.

SBPB RAI-4 – Description of the UHS outfall

Background –

Based on the application, the thermal discharge to the UHS pond would take place from two submerged 48-inch diameter pipes. There is little or no information on the configuration of these pipes.

Concern –

The complex circulation that would be caused by discharge from submerged pipes is not described in the UHS analysis and based on an audit conducted at the Braidwood site in July 2015, the NRC staff believes that the water is discharged straight up and above the lake level

Regulatory Basis

NUREG-0800, Standard Review Plan, provides guidance to the reviewer to verify that The UHS has the capability to dissipate the maximum possible total heat load by conducting independent check calculations. An understanding of the outfall configuration is needed.

Request –

Provide a detailed description of the UHS outfall, pipe drawings to outfall, results of any testing of the circulation in and around the outfall, and any model or prototype studies (e.g., dye tracer experiments) conduction with regard to its operation. To the extent that your response to the NRC staff's RAI dated September 29, 2015, addresses this request, a reference to that response is acceptable.

SBPB RAI-5 - Heat Removal Methods on the Shutdown Plant

Background

A significant heat load on the SX system is provided by the plant that is in a normal shutdown condition following an extended full power run.

Section 4.6 and Attachment C of ATD-0109 specify the heat rejected to the UHS during the DBA

Regulatory Basis

NUREG-0800, Standard Review Plan, provides guidance to the reviewer to verify that General Design Criterion 5 is met with respect to providing a safe and orderly shutdown of a unit while mitigating an accident in the other unit.

Issue

It is not clear that all of the decay heat from the shutdown plant is being removed by the SX system for the duration of the shutdown.

Request

Discuss the heat removal and cooldown of the non-accident unit as it relates to the heat load rejected to the UHS [Section 4.6 and Attachment C of ATD-0109] during the DBA.

SBPB RAI-6 - Surveillance 3.7.9.2

Background

Proposed Surveillance Requirement 3.7.9.2 states to verify average water temperature of UHS is ≤ 102°F in accordance with the Surveillance Frequency Control Program.

Regulatory Basis

NUREG-0800, Standard Review Plan, provides guidance to the reviewer to verify that the design of the sensing instrumentation is adequate.

Issue

The UHS becomes inoperable with a temperature > 102°F.

Request

Discuss how Exelon will ensure that operators become aware, within a reasonable amount of time, that the UHS has exceeded 102°F. What is the maximum time that the UHS could exceed 102°F before the operators became aware of the condition.

SBPB RAI-7 - Model Heat Input in 3 Hour Time Segments

Background

Table 7-3 of ATD 0109 shows an initial temperature of 96.4°F to achieve a maximum of plant inlet temperature of 104 °F. For an initial temperature of 102°F the maximum plant inlet temperature is 105.9 °F

Table 2 of the LAR shows 13 segments for the 3 pump case and 9 segments for the 4 pump case.

Table C2 of Attachment C of ATD 0109 shows plant temperature rises in intervals of 3 hours which is used as input data for each segment of the LAKET-PC model.

The calculation output for the limiting case is shown in Attachment 1 of the LAR showing a peak of 105.2°F.

The LAR justified 105.2°F as a cooling water supply to the equipment cooled by the UHS during a DBA.

Regulatory Basis

NUREG-0800, Standard Review Plan, provides guidance to the reviewer to verify that The UHS has the capability to dissipate the maximum possible total heat load by conducting independent check calculations. An understanding of the sensitivity of the LAR's analysis to the segment size is required.

Issue

Table 7-3 shows a relatively large delta between initial temperatures (96.4°F vs 102°F) of the UHS when compared to the delta for the corresponding maximum plant inlet temperatures (104°F vs 105.9°F). This could be indicative of coarse input data/coarse methodology.

Plant temperature rise data every 3 hours in a model with 9 and 13 segments seems to be coarse for output data measured in terms of a tenth of a degree, since each segment is filled and averaged over a 3 hour time period.

The 3 hour time segment of input data may not provide appropriate accuracy for calculation output measured in fractions of a degree Fahrenheit.
The NRC staff notes from the licensee's response to RAI 5 of the April 30, 2015 letter that each plug represents the volume produced by 3 hours of SX pump run time after the DBA. The staff also notes from Table C1 and Section 2.1.3 of ATD-0109, if each time step were 1 hour instead of 3 hours, the initial plug would be 5°F warmer than the plug produced from a 3 hour time step.
Request
To evaluate the sensitivity of the analysis to the time step, provide data from performing the limiting cases of 3 SX pump operation using data from plant temperature rise every 1 hour (with corresponding heat input on an hourly basis, instead of 3 hours) with an apparent LAKET-PC segment quantity of 36 to 39 segments. Provide a table and figure similar to Table 7-2 [Worst Temperature Cases – 3 SX Pumps] and Figure 7-1 [Limiting 3 SX Pump Case] of ATD 0109 and provide a corresponding Tables similar to Attachment C of ATD-0109.

SBPB RAI-8 - Description of Sedimentation in UHS Pond

Background
The LAR considered 3 inches of sedimentation in the UHS calculations for a sensitivity analysis. UFSAR Figure 2.4-48 shows a bottom/pond elevation of 584'-0". SR 3.7.9.3 verifies bottom level ≤ 584 ft MSL in accordance with the Surveillance Frequency Control Program.
The licensee's sensitivity analysis showed insignificant effect on peak UHS temperature with 3 inches of sedimentation.
Other licensees have considered as much as 18 inches of sedimentation in their submerged UHS pond.
Regulatory Basis
NUREG-0800, Standard Review Plan, provides guidance to the reviewer to verify that The UHS has the capability to dissipate the maximum possible total heat load by conducting independent check calculations. An understanding of the basis for 3 inches of sedimentation is required.
Request
Discuss whether SR 3.7.9.3 verifies validity of the design input of less than 3 inches of sedimentation for the UHS calculation by addressing accuracy of measurements, how often measurements are taken and any historical trends that support the frequency of measurements.

SBPB RAI-9 – Define limiting oil temperature

Background
Oil coolers are discussed as having at least 10°F margin between the maximum oil temperature reached and the limiting oil temperature.
Issue
It is not clear what is meant by "limiting oil temperature."
Regulatory Basis
NUREG-0800, Standard Review Plan, provides guidance to the reviewer to verify the capability of the system to provide adequate cooling to equipment.
Request
Clarify the term "limiting oil temperature" as to whether this is the temperature at which immediate bearing damage will begin to occur or whether this is a temperature at which the associated oil will begin to degrade more quickly or is a limit with margin imposed by the vendor or other limit.

SBPB RAI-10 – Thermodynamic simplified models, design calculations

Background
The licensee has stated in Section 3.5 of the LAR:
A formal engineering evaluation has been completed to review the impact of the increase in the UHS TS maximum temperature of 102°F and the increase in the maximum post-accident SX inlet temperature to 105.2°F. This was completed by reviewing the evaluations and design calculations for equipment cooled by the SX and CC systems and developing simplified models which were validated against the results of the existing calculations. The models replicated the analyses contained in the existing evaluations and design calculations with the increased SX temperature. Resulting margins were reviewed and it was determined that equipment cooled by the SX and CC systems have adequate margin at the elevated UHS temperature without physical plant modifications. The specific component analyses impacted by this evaluation have been identified and will be updated in accordance with the existing Engineering Change processes and as outlined in Regulatory Commitment #1.
Concern

The staff cannot make a reasonable assurance determination of acceptability based on simplified models that replicate the design calculations. The specific design work performed in accordance with 10CFR 50 Appendix B which justifies the amendment request, must be satisfactorily completed before NRC can make this determination.

Regulatory Basis

NUREG-0800, Standard Review Plan, provides guidance to the reviewer to verify the capability of the system to provide adequate cooling to equipment.

Request

The licensee is requested to complete the license amendment process by completing design calculations per 10 CFR 50 Appendix B for equipment cooled by the UHS. Section 3.5 of the LAR should be resubmitted basing the evaluation of equipment on the design calculations, not simplified models.

SBPB RAI-11 – Main Control Room Chiller

Background

Attachment 7 provides the vendor data sheet for the Main Control Room Chiller Condenser and shows a flow rate of 950 GPM at 100 F inlet temperature.

Issue

The licensee states that over 25% margin exists at maximum SX inlet temperature of 105.2 F using reduced fouling factors based on as found fouling factors of other heat exchangers in the GL-89-13 program. The Main Control Room Chiller operates frequently; some GL 89-13 heat exchangers operate infrequently and thus have small fouling factors.

Regulatory Basis

NUREG-0800, Standard Review Plan, provides guidance to the reviewer to verify the capability of the system to provide adequate cooling to equipment.

Request

Identify the equipment associated with the “as found fouling factors of other heat exchangers in the GL-89-13 program,” that were used to determine that the MCR chillers have over 25 % margin. Compare running times with the MCR chillers (if necessary). Discuss and provide validation of the evaluation which shows “over 25 % margin” at the maximum post-accident SX inlet temperature to 105.2 F.

SBPB RAI-12 – Emergency Diesel Generators

Background

Attachment 6, Emergency Diesel Generator (EDG) Jacket Water Coolers, is the vendor data sheet and shows a tube side flow rate of 1641 GPM at 100 F inlet temperature.

Issue

The licensee states all engine coolers cooled by SX have margin for the increased SX temperature. The LAR states that all equipment cooled by UHS is evaluated for the limiting UHS temperature of 105.2 F.

Regulatory Basis

NUREG-0800, Standard Review Plan, provides guidance to the reviewer to verify the capability of the system to provide adequate cooling to equipment.

Request

1) The licensee is requested to provide the following information for the emergency diesel generators: a) design fouling factor, b) as tested fouling factor (Generic Letter 89-13 test results) and frequency of testing, c) tube plugging allowance, d) actual number of tubes plugged, e) design heat load, f) actual SX flow rate g) calculated heat removal capability with design fouling factor and at 105.2 F (specify # tubes plugged and SX flow rate).

2) Using the calculated heat removal capability as requested above, provide the margin at the increased SX temperature.

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Created By: Joel.Wiebe@nrc.gov

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"Jessica Krejcie" <Jessica.Krejcie@exeloncorp.com>
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Post Office:

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