Industry/TSTF Standard Technical Specification Change Traveler

Ice Mass Determination Surveillance Requirements

NUREGs Affected: ☐ 1430 ☑ 1431 ☐ 1432 ☐ 1433 ☐ 1434

Classification: 1) Technical Change | Recommended for CLIIP?: No

Priority: 1)High

Simple or Complex Change: Complex | Correction or Improvement: Improvement

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1.0 Description

The proposed change would revise the Ice Bed Technical Specification (TS) and associated TS Bases in Surveillance Requirement (SR) 3.6.15.2.

2.0 Proposed Change

The proposed change to SR 3.6.15.2: 1) modifies the stored ice mass to 2,200,000 lbs by specifying the design basis value and removing maintenance allowances for sublimation allowance and mass determination accuracy; 2) redefines the ice mass statistical sampling plan to include the entire ice bed (1944 baskets), divides the ice bed into three radial zones, and modifies the sample size to at least 30 baskets in each radial zone; and 3) modifies the frequency from 9 months to 18 months.

The proposed change to SR 3.6.15.3: 1) removes the reference to azimuthal distribution verification; 2) adds a new acceptance criteria value for minimum ice mass in each basket sampled by SR 3.6.15.2; and 3) modifies the frequency from 9 months to 18 months.

The proposed change to SR 3.6.15.6 removes the reference to SR 3.6.15.3, that provided the definition of azimuthal distribution, and adds the current sampling distribution methodology directly to the SR for clarity.

Minor clarifying changes are proposed to the Bases 3.6.15 Background and LCO sections.

Bases SR 3.6.15.2 are rewritten consistent with the proposed changes to the SR. These proposed changes include: 1) ice mass verification in the as-found (pre-maintenance) condition; 2) redefinition of the ice mass statistical sampling plan to include the entire ice bed (1944 baskets), dividing the ice bed into three radial zones, and modifying the sample size to at least 30 baskets in each radial zone; 3) description of additional ice mass beyond the SR requirements that is maintained to address the effects of sublimation; 4) provision for ice mass determination by direct lifting or alternate techniques; and 5) redefinition of alternate basket selection criteria to include location parameters of an alternate selection basket and a criteria that restricts consecutive use of a specific basket as an alternate selection.

Bases SR 3.6.15.3 is rewritten consistent with the proposed changes to the SR, including replacement of azimuthal distribution verification with verification of a minimum ice mass for each basket sampled in SR 3.6.15.2.

The proposed change to Bases SR 3.6.15.4 corrects a typographical error.

The proposed change to Bases 3.6.15.6 replaces guidance to raise a basket for inspection with clarifying guidance that indicates the intent of the inspection is to perform an inspection of the full-length of the basket. Additionally, sampling methodology is directly defined, eliminating the reference to another SR.

The Bases Reference is expanded with the addition of Topical Report ICUG-001.

3.0 Background

Industry events and issues related to the ice condenser prompted a review of related TSs by the Ice Condenser Utility Group (ICUG). The ICUG is comprised of utility members from the domestic ice condenser plants. Through TS reviews, differences were identified between each ice condenser plant's interpretation and implementation of the related TSs. ICUG review of the ice weight TS determined that the specification was adequate to show operability; however, some concepts from which the original specification was derived have changed, and others needed clarification. As a result, several changes are proposed to the ice mass TS that improve the tie to design basis and apply: 1) collective ICUG operating experience history, and 2) inherent linkage to plant-specific maintenance practices.

4.0 Technical Analysis

The basic requirement for verification of ice condenser ice bed ice mass is to ensure a sufficient ice mass is available to provide a heat sink in the event of an energy release in containment from a loss-of-coolant accident (LOCA) or a steam line break (SLB). For these design basis accidents (DBAs), the ice would absorb energy and limit containment peak pressure and temperature during the accident transient. Limiting the pressure and temperature reduces the release of fission product radioactivity from containment to the environment in the event of a DBA.

The proposed change of the total stored ice mass provides consistency with the design basis analysis. The acceptance criteria value is reduced by relocation of sublimation allowance and mass determination accuracy to the Bases. The Bases are modified to state that the surveillance is performed in the as-found condition (before ice bed maintenance and after ice bed sublimation). The current acceptance criteria value consists of DBA analysis values, a generic 15 percent sublimation allowance, a one percent mass determination accuracy (weighing error) value, and the surveillance is performed in the as-left condition (after ice bed maintenance and before ice bed sublimation) to show adequacy for the next operational cycle. The as-found performance of this surveillance shows adequacy of total ice mass for the current operational cycle. As such, when the proposed SR change is coupled with the change to the SR Bases, there is no net change in total stored ice mass. ICUG operational history shows that sublimation rates vary within the ice bed requiring specific effort to maintain the ice bed mass inventory each outage. The ongoing process of monitoring the varying sublimation rates during the operating cycle and replenishing ice bed mass as needed is the basis for the Active Ice Mass Management (AIMM) concept. The maintenance effort (AIMM) restores the ice bed mass and distribution characteristics required for continued operation. Therefore, the proposed change provides a clear tie to the design basis while crediting plant specific AIMM maintenance practices.

The proposed statistical sampling plan change increases the parent population to include all ice baskets contained within the ice bed, stratifies that population into three radial zones that contain rows of ice baskets exhibiting similar characteristics, and requires at least 30 random sample ice baskets for ice mass verification in each radial zone. The stratified sampling allows sub-populations to be defined that have similar mean mass characteristics resulting in better estimates of total ice mass. A 30-ice basket random sample from each radial zone maintains a 95 percent confidence level for calculation of total stored ice. The modified sampling methodology provides the validation of total ice mass and verification of ice mass distribution within the ice bed, in lieu of a limited azimuthal row-group surveillance. The proposed ice bed sub-populations (radial zones) and sample size directly applies ICUG ice bed historical operating experience, provides clear linkage to statistical sampling methodology provided in NRC NUREG-1475, "Applying Statistics," and supports validation of total stored ice for the long-term/overall DBA analysis.

The proposed change to remove limited azimuthal row-group ice distribution verification is replaced by the change in statistical sampling. As stated above, the change in statistical sampling and crediting of AIMM processes provides inherent verification of ice mass distribution making azimuthal row-group distribution verification redundant. A new minimum ice mass acceptance criterion is added for each of the ice baskets sampled. The new acceptance criterion (minimum ice mass for each basket sampled) ensures that a significant localized degraded mass condition of the ice bed does not exist. The value of this acceptance criterion is based on the minimum amount of ice needed to avoid any challenge to the DBA containment pressure response. The basis includes consideration of data from the original testing performed by Westinghouse Electric Corporation at the Waltz-Mill Test Facility, and sensitivity runs performed using the GOTHIC analytical code.

The proposed change to the ice basket wear/damage SR only provides clarification of the sampling methodology. Currently the SR references the ice mass verification SR for sampling methodology. Because the ice mass verification sampling methodology is proposed to change, the reference is being removed and the current sampling methodology is completely defined.

The change to an 18-month frequency for both the ice mass verification and the ice distribution SRs does not result in an overall reduction in the end-of-cycle ice mass. The process of replenishing the ice bed mass and the monitoring of varying sublimation rates during the operating cycle is the basis for AIMM. AIMM restores the ice bed mass and distribution characteristics required for continued operation. This includes sublimation allowances and ice mass determination accuracy. ICUG historical operating experience has shown that the ice condenser can meet and even exceed its design function without performing these surveillances on a 9-month frequency. Additionally, this change in frequency places performance of these SRs within the time frame of the ice condenser plant refueling outages.

Overall, ice condenser operability is assured by numerous means during operation of the plant. The ice bed temperature is monitored at least once every 12 hours to ensure temperatures are less than or equal to 27 degrees F. There are alarms in the main control room that will indicate to the operator if any recorded temperature monitoring point within the ice bed approaches 27 degrees F. The plant staff performs tours and walkdowns of the refrigeration system to evaluate its ability to function. These activities includes walkdowns of chillers, air handling units, and glycol circulation pumps to ensure that they are in proper working order. Inspections are required of intermediate deck doors to ensure they are not impaired. This activity ensures that no abnormal degradation of the ice condenser is occurring due to condensation or frozen drain lines in localized areas.

5.0 Regulatory Analysis

5.1 No Significant Hazards Consideration

The TSTF has evaluated whether or not a significant hazards consideration is involved with the proposed generic change 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 TS amendment does not result in a physical change or operational change to the ice condenser. Additionally, there is no change to the existing design requirements or inputs/results of any accident analysis calculations relative to the ice condenser. Therefore, the proposed change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

Regarding the consequences of analyzed accidents, the ice condenser is an engineered safety feature designed, in part, to limit the containment sub-compartment and containment vessel pressures immediately following the initiation of a loss-of-coolant accident (LOCA) or steam line break (SLB). Conservative sub-compartment and containment vessel pressure analysis shows this criteria will be met if the total ice mass within the ice bed is maintained in accordance with the DBA analysis. The changes to the total stored ice mass SR is consistent with the DBA analysis; and therefore, the TS SR changes of these requirements will not increase the consequences of any accident previously evaluated.

The proposed changes to the ice distribution SR does not result in any effect on plant equipment or operation and the actions taken during the implementation of the revised TS will be the same as prior to the revision. These changes ensure consistent interpretation and application of TS requirements and provide validation of the ice condenser ice bed total ice mass and ice distribution to the DBA analysis and ensure the DBA analysis is supported. Therefore, the TS SR changes of these requirements will not increase the consequences of any accident previously evaluated.

Ice condenser plant historical operating experience has shown that the ice condenser can meet and even exceed its design function with performing ice mass verification and ice distribution SRs on a 18 month frequency. As such, the decrease from a 9 month frequency for both of these SRs does not result in an overall reduction in the end-of-cycle ice mass. The maintenance process replenishes the ice bed mass and monitors sublimation rates during the operating cycle. Maintenance of the ice bed restores the ice bed mass and distribution characteristics required for continued operation, including sublimation allowances and ice mass determination accuracy. Additionally, performance of the SRs in the as-found condition validates compliance with the DBA analysis and quality of maintenance performance for the current operating cycle. Therefore, decreasing the surveillance frequency does not affect the ice condenser operation or accident response since sufficient ice is maintained to address the limiting DBAs and the proposed amendment will not increase the consequences of any accident previously evaluated.

Therefore, the proposed change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

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 TS amendment does not result in a physical change or operational change to the ice condenser. Additionally, there is no change to the existing design requirements or inputs/results of any accident analysis calculations relative to the ice condenser.

Therefore, the proposed change does not create the possibility of 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 changes to the TS SR does not result in or have any effect on the operation of any plant equipment. The change in ice mass makes the TS SR acceptance value consistent with design basis analysis. The change in sampling methodology maintains a 95 percent confidence level for calculation of total stored ice. The proposed change in sampling methodology and crediting the Active Ice Mass Management concept validates ice distribution. The addition of a minimum ice mass acceptance criterion for each of the ice baskets sampled ensures the ice bed condition is consistent with the initial conditions of the DBA by limiting localized degradation to avoid any challenge to the DBA containment pressure response.

The change to the ice basket structural integrity SR provides consistency between the ice bed TS SRs. The change maintains ice bed design limits and the continued safe function of the containment structure following a DBA is not affected due to this change; therefore, the proposed amendment does not involve a reduction in a margin of safety.

The ice condenser system is provided to absorb thermal energy releases following a LOCA or SLB and to limit the peak pressure inside containment. The containment analysis shows that the proposed amendment to revise the frequency of the SRs from every 9 months to every 18 months will not result in an increase to the peak containment pressure following a LOCA or SLB since the minimum ice mass limit (for both short- and long-term phases of the DBA) has been adequately addressed, ensuring that sufficient ice is available at the end of the surveillance interval. Therefore, decreasing the surveillance frequency will not affect the ice condenser operation or accident response since sufficient ice is maintained to address the limiting DBAs and the design limits for the continued safe function of the containment structure following a DBA are not affected.

Therefore, the proposed change does not involve a significant reduction in a margin of safety.

Based on the above, the TSTF concludes that the proposed change presents no 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.

5.2 Applicable Regulatory Requirements

General Design Criteria 50, "Containment Design Basis," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, requires that the nuclear power plant containment structure and its internal compartments accommodate the calculated pressure and temperature conditions resulting from any loss-of-coolant accident with consideration of the effects of potential energy sources such as the steam generators.

Based in the considerations discussed above and the evaluation provided by Topical Report ICUG-001, (1) there is reasonable assurance that the health and safety of the public will not be endangered by the operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the approval of the proposed change will not adversely affect the common defense and security or to the health and safety of the public.

6.0 Environmental Impact Consideration

The proposed change does not (i) involve a significant hazards consideration, (ii) a significant change in the types of or 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 change meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), an environmental impact statement or environmental assessment of the proposed change is not required.

7.0 References

None

Revision History

OG Revision 0 Revision Status: Closed

Revision Proposed by: Sequoyah

Revision Description:
Original Issue

Owners Group Review Information

Date Originated by OG: 05-Dec-01

Owners Group Comments
(No Comments)

Owners Group Resolution: Approved Date: 05-Dec-01

TSTF Review Information

TSTF Received Date: 16-Dec-01 Date Distributed for Review 04-Jan-02

OG Review Completed: ☑ BWOG ☑ WOG ☑ CEOG ☑ BWROG

TSTF Comments:

(No Comments)

TSTF Resolution: Approved Date: 23-Jan-02

OG Revision 0 Revision Status: Closed

NRC Review Information

NRC Received Date: 30-Jan-02

NRC Comments:

Verbal comments received from NRC. See change description of Revision 1.

Final Resolution: NRC Requests Changes: TSTF Will Revise Final Resolution Date: 26-Nov-02

TSTF Revision 1 Revision Status: Active Next Action: NRC

Revision Proposed by: WOG

Revision Description:
This revision incorporates changes to provide additional clarification and resolve concerns identified in request for additional information received from NRC staff. Also, the revision provides some editorial corrections.

The bracketed ice mass values in SR 3.6.15.2 and SR 3.6.15.3 are revised to current licensing basis values for an ice condenser plant (i.e., DC Cook). The TS Bases for SR 3.6.15.2 has been revised to clarify Licensee's goals for maintaining each ice basket above the requirements of TSs. The wording of SR 3.6.15.3 is revised to delete "blowdown" as the basis for the minimum ice mass value. Instead, the TS Bases for SR 3.6.15.3 clarifies that the basis for the acceptance criterion is the minimum amount of ice needed to avoid any challenge to the DBA containment pressure response.

TSTF Review Information

TSTF Received Date: 27-Nov-02 Date Distributed for Review 27-Nov-02

OG Review Completed: ☑ BWOG ☑ WOG ☑ CEOG ☑ BWROG

TSTF Comments:

(No Comments)

TSTF Resolution: Approved Date: 06-Dec-02

NRC Review Information

NRC Received Date: 13-Dec-02

Affected Technical Specifications

Bkgnd 3.6.15 Bases	Ice Bed
LCO 3.6.15 Bases	Ice Bed
Ref. 3.6.15 Bases	Ice Bed
SR 3.6.15.2	Ice Bed

SR 3.6.15.2 Bases	Ice Bed
SR 3.6.15.3	Ice Bed
SR 3.6.15.3 Bases	Ice Bed
SR 3.6.15.6	Ice Bed
SR 3.6.15.6 Bases	Ice Bed

Insert A

Verify total mass of stored ice is ≥ [2,200,000] lbs by calculating the mass of stored ice, at a 95% confidence level, in each of three Radial Zones as defined below, by selecting a random sample of ≥ 30 ice baskets in each Radial Zone, and

Verify:

1. Zone A (radial rows [*7,8,9*]), has a total mass of ≥ [*733,400*] lbs
2. Zone B (radial rows [*4*,*5*,*6*]), has a total mass of ≥ [*733,400*] lbs
3. Zone C (radial rows [*1,2,3*]), has a total mass of ≥ [*733,400*] lbs.

Insert B

Verify that the ice mass of each basket sampled in SR 3.6.15.2 is ≥ 600 lbs.

Insert C

as defined below:

a. Group 1- bays 1 through 8;

b. Group 2- bays 9 through 16; and

c. Group 3- bays 17 through 24.

Insert D

Ice mass determination methodology is designed to verify the total as-found (pre-maintenance) mass of ice in the ice bed, and the appropriate distribution of that mass, using a random sampling of individual baskets. The random sample will include at least 30 baskets from each of three defined Radial Zones (at least 90 baskets total). Radial Zone A consists of baskets located in rows [7, 8, and 9] (innermost rows adjacent to the Crane Wall), Radial Zone B consists of baskets located in rows [4, 5, and 6] (middle rows of the ice bed), and Radial Zone C consists of baskets located in rows [1, 2, and 3] (outermost rows adjacent to the Containment Vessel).

The Radial Zones chosen include the row groupings nearest the inside and outside walls of the ice bed and the middle rows of the ice bed. These groupings facilitate the statistical sampling plan by creating sub-populations of ice baskets that have similar mean mass and sublimation characteristics.

Methodology for determining sample ice basket mass will be either by direct lifting or by alternative techniques. Any method chosen will include procedural allowances for the accuracy of the method used. The number of sample baskets in any Radial Zone may be increased as necessary to verify the total mass of that Radial Zone.

In the event the mass of a selected basket in a sample population (initial or expanded) cannot be determined by any available means (e.g., due to surface ice accumulation or obstruction), a randomly selected representative alternate basket may be used to replace the original selection in that sample population. If employed, the representative alternate must meet the following criteria:

a. Alternate selection must be from the same bay-Zone (i.e., same bay, same Radial Zone) as the original selection, and

b. Alternate selection cannot be a repeated selection (original or alternate) in the current Surveillance, and cannot have been used as an analyzed alternate selection in the three most recent Surveillances.

The complete basis for the methodology used in establishing the 95% confidence level in the total ice bed mass is documented in Ref. 4.

The total ice mass and individual Radial Zone ice mass requirements defined in this Surveillance, and the minimum ice mass per basket requirement defined by SR 3.6.15.3, are the minimum requirements for OPERABILITY. Additional ice mass beyond the SRs is maintained to address sublimation. This sublimation allowance is generally applied to baskets in each Radial Zone, as appropriate, at the beginning of an operating cycle to ensure sufficient ice is available at the end of the operating cycle for the ice condenser to perform its intended design function. As documented in Ref. 4, maintenance practices actively manage individual ice basket mass above the required safety analysis mean for each Radial Zone. Specifically, each basket is serviced to keep its ice mass above [1132] lbs for Radial Zone A, [1132] lbs for Radial Zone B, and [1132] lbs for Radial Zone C. If any basket is identified to be deficient with respect to these ice mass values, this condition is to be addressed in the corrective action program. This alone is not considered a significant condition adverse to quality as long as the ice mass requirements of SR 3.6.15.2 and SR 3.6.15.3 remain satisfied.

The Frequency of 18 months was based on ice storage tests, and the typical sublimation allowance maintained in the ice mass over and above the minimum ice mass assumed in the safety analyses. Operating and maintenance experience has verified that, with the 18 month Frequency, the minimum mass and distribution requirements in the ice bed are maintained.

Insert E

Verifying that each selected sample basket from SR 3.6.15.2 contains at least 600 lbs of ice in the as-found (pre-maintenance) condition ensures that a significant localized degraded mass condition is avoided.

This SR establishes a per basket limit to ensure any ice mass degradation is consistent with the initial conditions of the DBA by not significantly affecting the containment pressure response. Ref. 4 provides insights through sensitivity runs that demonstrate that the containment peak pressure during a DBA is not significantly affected by the ice mass in a large localized region of baskets being degraded below the required safety analysis mean, when the Radial Zone and total ice mass requirements of SR 3.6.15.2 are satisfied. Any basket identified as containing less than 600 lbs of ice requires appropriately entering the TS Required Action for an inoperable ice bed due to the potential that it may represent a significant condition adverse to quality.

Insert F

The SR is designed around a full-length inspection of a sample of baskets, and is intended to monitor the effect of the ice condenser environment on ice baskets. The groupings defined in the SR (two baskets in each azimuthal third of the ice bed) ensure that the sampling of baskets is reasonably distributed.

3.6 CONTAINMENT SYSTEMS

3.6.15 Ice Bed (Ice Condenser)

LCO 3.6.15 The ice bed shall be OPERABLE.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Ice bed inoperable.	A.1 Restore ice bed to OPERABLE status.	48 hours
B. Required Action and associated Completion Time not met.	B.1 Be in MODE 3. AND B.2 Be in MODE 5.	6 hours 36 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.6.15.1	Verify maximum ice bed temperature is ≤ [27]°F.	12 hours
SR 3.6.15.2	Insert A Verify total weight of stored ice is ≥ [2,721,600] lb by: a. Weighing a representative sample of ≥ 144 ice baskets and verifying each basket contains ≥ [1400] lb of ice and b. Calculating total weight of stored ice, at a 95% confidence level, using all ice basket weights determined in SR 3.6.15.2.a.	9 months 18

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.6.15.3	Insert B → Verify azimuthal distribution of ice at a 95% confidence level by subdividing weights, as determined by SR 3.6.15.2.a, into the following groups: a. Group 1 - bays 1 through 8, b. Group 2 - bays 9 through 16, and c. Group 3 - bays 17 through 24. The average ice weight of the sample baskets in each group from radial rows 1, 2, 4, 6, 8, and 9 shall be ≥ [1400] lb.	9 months 18
SR 3.6.15.4	Verify, by visual inspection, accumulation of ice on structural members comprising flow channels through the ice bed is ≤ 15 percent blockage of the total flow area for each safety analysis section.	18 months
SR 3.6.15.5	- NOTE - The requirements of this SR are satisfied if the boron concentration and pH values obtained from averaging the individual sample results are within the limits specified below. Verify, by chemical analysis of the stored ice in at least one randomly selected ice basket from each ice condenser bay, that ice bed: a. Boron concentration is a ≥ [1800] ppm and ≤ [2000] ppm; and b. pH is ≥ [9.0] and ≤ [9.5].	[54] months
SR 3.6.15.6	Visually inspect, for detrimental structural wear, cracks, corrosion, or other damage, two ice baskets from each azimuthal group of bays. See SR 3.6.15.3. Insert C	40 months

B 3.6 CONTAINMENT SYSTEMS

B 3.6.15 Ice Bed (Ice Condenser)

BASES

a minimum of [2,200,000]

BACKGROUND

The ice bed consists of ~~over [2,721,600]~~ lb of ice stored ~~in 1944 baskets~~ within the ice condenser. ~~Its~~ The primary purpose of the ice bed is to provide a large heat sink in the event of a release of energy from a Design Basis Accident (DBA) in containment. The ice would absorb energy and limit containment peak pressure and temperature during the accident transient. Limiting the pressure and temperature reduces the release of fission product radioactivity from containment to the environment in the event of a DBA.

The ice condenser is an annular compartment enclosing approximately 300° of the perimeter of the upper containment compartment, but penetrating the operating deck so that a portion extends into the lower containment compartment. The lower portion has a series of hinged doors exposed to the atmosphere of the lower containment compartment, which, for normal unit operation, are designed to remain closed. At the top of the ice condenser is another set of doors exposed to the atmosphere of the upper compartment, which also remain closed during normal unit operation. Intermediate deck doors, located below the top deck doors, form the floor of a plenum at the upper part of the ice condenser. These doors also remain closed during normal unit operation. The upper plenum area is used to facilitate surveillance and maintenance of the ice bed.

The ice baskets contain the ice within the ice condenser. The ice bed is considered to consist of the total volume from the bottom elevation of the ice baskets to the top elevation of the ice baskets. The ice baskets position the ice within the ice bed in an arrangement to promote heat transfer from steam to ice. This arrangement enhances the ice condenser's primary function of condensing steam and absorbing heat energy released to the containment during a DBA.

In the event of a DBA, the ice condenser inlet doors (located below the operating deck) open due to the pressure rise in the lower compartment. This allows air and steam to flow from the lower compartment into the ice condenser. The resulting pressure increase within the ice condenser causes the intermediate deck doors and the top deck doors to open, which allows the air to flow out of the ice condenser into the upper compartment. Steam condensation within the ice condenser limits the pressure and temperature buildup in containment. A divider barrier (i.e., operating deck and extensions thereof)

BASES

BACKGROUND (continued)

separates the upper and lower compartments and ensures that the steam is directed into the ice condenser.

The ice, together with the containment spray, is adequate to absorb the initial blowdown of steam and water from a DBA and the additional heat loads that would enter containment during several hours following the initial blowdown. The additional heat loads would come from the residual heat in the reactor core, the hot piping and components, and the secondary system, including the steam generators. During the post blowdown period, the Air Return System (ARS) returns upper compartment air through the divider barrier to the lower compartment. This serves to equalize pressures in containment and to continue circulating heated air and steam from the lower compartment through the ice condenser where the heat is removed by the remaining ice.

As ice melts, the water passes through the ice condenser floor drains into the lower compartment. Thus, a second function of the ice bed is to be a large source of borated water (via the containment sump) for long term Emergency Core Cooling System (ECCS) and Containment Spray System heat removal functions in the recirculation mode.

A third function of the ice bed and melted ice is to remove fission product iodine that may be released from the core during a DBA. Iodine removal occurs during the ice melt phase of the accident and continues as the melted ice is sprayed into the containment atmosphere by the Containment Spray System. The ice is adjusted to an alkaline pH that facilitates removal of radioactive iodine from the containment atmosphere. The alkaline pH also minimizes the occurrence of the chloride and caustic stress corrosion on mechanical systems and components exposed to ECCS and Containment Spray System fluids in the recirculation mode of operation.

exist in the ice baskets, the ice to be appropriately (1)

It is important for the ice to be uniformly distributed around the 24 ice condenser bays, and for open flow paths to exist around ice baskets. This is especially important during the initial blowdown so that the steam and water mixture entering the lower compartment do not pass through only part of the ice condenser, depleting the ice there while bypassing the ice in other bays.

Two phenomena that can degrade the ice bed during the long service period are:

a. Loss of ice by melting or sublimation and

BASES

BACKGROUND (continued)

b. Obstruction of flow passages through the ice bed due to buildup of frost or ice. Both of these degrading phenomena are reduced by minimizing air leakage into and out of the ice condenser.

The ice bed limits the temperature and pressure that could be expected following a DBA, thus limiting leakage of fission product radioactivity from containment to the environment.

APPLICABLE SAFETY ANALYSES

The limiting DBAs considered relative to containment temperature and pressure are the loss of coolant accident (LOCA) and the steam line break (SLB). The LOCA and SLB are analyzed using computer codes designed to predict the resultant containment pressure and temperature transients. DBAs are not assumed to occur simultaneously or consecutively.

Although the ice condenser is a passive system that requires no electrical power to perform its function, the Containment Spray System and the ARS also function to assist the ice bed in limiting pressures and temperatures. Therefore, the postulated DBAs are analyzed in regards to containment Engineered Safety Feature (ESF) systems, assuming the loss of one ESF bus, which is the worst case single active failure and results in one train each of the Containment Spray System and ARS being inoperable.

The limiting DBA analyses (Ref. 1) show that the maximum peak containment pressure results from the LOCA analysis and is calculated to be less than the containment design pressure. For certain aspects of the transient accident analyses, maximizing the calculated containment pressure is not conservative. In particular, the cooling effectiveness of the ECCS during the core reflood phase of a LOCA analysis increases with increasing containment backpressure. For these calculations, the containment backpressure is calculated in a manner designed to conservatively minimize, rather than maximize, the calculated transient containment pressures, in accordance with 10 CFR 50, Appendix K (Ref. 2). The maximum peak containment atmosphere temperature results from the SLB analysis and is discussed in the Bases for LCO 3.6.5, "Containment Air Temperature."

In addition to calculating the overall peak containment pressures, the DBA analyses include calculation of the transient differential pressures that occur across subcompartment walls during the initial blowdown phase of the accident transient. The internal containment walls and

BASES

APPLICABLE SAFETY ANALYSES (continued)

structures are designed to withstand these local transient pressure differentials for the limiting DBAs.

The ice bed satisfies Criterion 3 of 10 CFR 50.36(c)(2)(ii).

LCO

the blowdown phase and long term phase of

stored

The ice bed LCO requires the existence of the required quantity of stored ice, appropriate distribution of the ice and the ice bed, open flow paths through the ice bed, and appropriate chemical content and pH of the stored ice. The stored ice functions to absorb heat during a DBA, thereby limiting containment air temperature and pressure. The chemical content and pH of the ice provide core SDM (boron content) and remove radioactive iodine from the containment atmosphere when the melted ice is recirculated through the ECCS and the Containment Spray System, respectively.

APPLICABILITY

In MODES 1, 2, 3, and 4, a DBA could cause an increase in containment pressure and temperature requiring the operation of the ice bed. Therefore, the LCO is applicable in MODES 1, 2, 3, and 4.

In MODES 5 and 6, the probability and consequences of these events are reduced due to the pressure and temperature limitations of these MODES. Therefore, the ice bed is not required to be OPERABLE in these MODES.

ACTIONS

A.1

If the ice bed is inoperable, it must be restored to OPERABLE status within 48 hours. The Completion Time was developed based on operating experience, which confirms that due to the very large mass of stored ice, the parameters comprising OPERABILITY do not change appreciably in this time period. Because of this fact, the Surveillance Frequencies are long (months), except for the ice bed temperature, which is checked every 12 hours. If a degraded condition is identified, even for temperature, with such a large mass of ice it is not possible for the degraded condition to significantly degrade further in a 48 hour period. Therefore, 48 hours is a reasonable amount of time to correct a degraded condition before initiating a shutdown.

B.1 and B.2

If the ice bed cannot be restored to OPERABLE status within the required Completion Time, the plant must be brought to a MODE in which the

BASES

ACTIONS (continued)

LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and to MODE 5 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems.

SURVEILLANCE REQUIREMENTS

SR 3.6.15.1

Verifying that the maximum temperature of the ice bed is ≤ [27]°F ensures that the ice is kept well below the melting point. The 12 hour Frequency was based on operating experience, which confirmed that, due to the large mass of stored ice, it is not possible for the ice bed temperature to degrade significantly within a 12 hour period and was also based on assessing the proximity of the LCO limit to the melting temperature.

Furthermore, the 12 hour Frequency is considered adequate in view of indications in the control room, including the alarm, to alert the operator to an abnormal ice bed temperature condition. This SR may be satisfied by use of the Ice Bed Temperature Monitoring System.

SR 3.6.15.2

Insert D

The weighing program is designed to obtain a representative sample of the ice baskets. The representative sample shall include 6 baskets from each of the 24 ice condenser bays and shall consist of one basket from radial rows 1, 2, 4, 6, 8, and 9. If no basket from a designated row can be obtained for weighing, a basket from the same row of an adjacent bay shall be weighed.

The rows chosen include the rows nearest the inside and outside walls of the ice condenser (rows 1 and 2, and 8 and 9, respectively), where heat transfer into the ice condenser is most likely to influence melting or sublimation. Verifying the total weight of ice ensures that there is adequate ice to absorb the required amount of energy to mitigate the DBAs.

If a basket is found to contain < [1400] lb of ice, a representative sample of 20 additional baskets from the same bay shall be weighed. The average weight of ice in these 21 baskets (the discrepant basket and the 20 additional baskets) shall be ≥ [1400] lb at a 95% confidence level.

BASES

SURVEILLANCE REQUIREMENTS (continued)

Weighing 20 additional baskets from the same bay in the event a Surveillance reveals that a single basket contains < [1400] lb ensures that no local zone exists that is grossly deficient in ice. Such a zone could experience early melt out during a DBA transient, creating a path for steam to pass through the ice bed without being condensed. The Frequency of 9 months was based on ice storage tests and the allowance built into the required ice mass over and above the mass assumed in the safety analyses. Operating experience has verified that, with the 9 month Frequency, the weight requirements are maintained with no significant degradation between surveillances.

SR 3.6.15.3

Insert E

This SR ensures that the azimuthal distribution of ice is reasonably uniform, by verifying that the average ice weight in each of three azimuthal groups of ice condenser bays is within the limit. The Frequency of 9 months was based on ice storage tests and the allowance built into the required ice mass over and above the mass assumed in the safety analyses. Operating experience has verified that, with the 9 month Frequency, the weight requirements are maintained with no significant degradation between surveillances.

SR 3.6.15.4

This SR ensures that the flow channels through the ice bed have not accumulated ice blockage that exceeds 15 percent of the total flow area through the ice bed region. The allowable 15 percent buildup of ice is based on the analysis of the sub-compartment response to a design basis LOCA with partial blockage of the ice condenser flow channels. The analysis did not perform detailed flow area modeling, but lumped the ice condenser bays into six sections ranging from 2.75 bays to 6.5 bays. Individual bays are acceptable with greater than 15 percent blockage, as long as 15 percent blockage is not exceeded for any analysis section.

To provide a 95 percent confidence that flow blockage does not exceed the allowed 15 percent, the visual inspection must be made for at least 54 (33 percent) of the 162 flow channels per ice condenser bay. The visual inspection of the ice bed flow channels is to inspect the flow area, by looking down from the top of the ice bed, and where view is achievable up from the bottom of the ice bed. Flow channels to be inspected are determined by random sample. As the most restrictive ice bed flow passage is found at a lattice frame elevation, the 15 percent blockage criteria only applies to "flow channels" that comprise the area:

BASES

SURVEILLANCE REQUIREMENTS (continued)

a. between ice baskets, and

b. past lattice frames and wall panels.

Due to significantly larger flow area in the regions of the upper deck grating and the lower inlet plenum support structures and turning vanes, a gross buildup of ice on these structures would be required to degrade air and steam flow. Therefore, these structures are excluded as part of a flow channel for application of the 15 percent blockage criteria. Industry experience has shown that removal of ice from the excluded structures during the refueling outage is sufficient to ensure they remain operable throughout the operating cycle. Removal of any gross ice buildup on the excluded structures is performed following outage maintenance activities.

Operating experience has demonstrated that the ice bed is the region that is the most flow restrictive, due to the normal presence of ice accumulation of lattice frames and wall panels. The flow area through the ice basket support platform is not a more restrictive flow area because it is easily accessible from the lower plenum and is maintained clear of ice accumulation. There is no mechanistically credible method for ice to accumulate on the ice basket support platform during plant operation. Plant and industry experience has shown that the vertical flow area through the ice basket support platform remains clear of ice accumulation that could produce blockage. Normally only a glaze may develop or exist on the ice basket support platform which is not significant to blockage of flow area. Additionally, outage maintenance practices provide measures to clear the ice basket support platform following maintenance activities of any accumulation of ice that could block flow areas.

On

Frost buildup or loose ice is not to be considered as flow channel blockage, whereas attached ice is considered blockage of a flow channel. Frost is the solid form of water that is loosely adherent, an can be brushed off with the open hand.

SR 3.6.15.5

Verifying the chemical composition of the stored ice ensures that the stored ice has a boron concentration ≥ [1800] ppm and ≤ [2000] ppm as sodium tetraborate and a high pH, ≥ [9.0] and ≤ [9.5], in order to meet the requirement for borated water when the melted ice is used in the ECCS recirculation mode of operation. Additionally, the minimum boron concentration setpoint is used to assure reactor subcriticality in a post

BASES

SURVEILLANCE REQUIREMENTS (continued)

LOCA environment, while the maximum boron concentration is used as the bounding value in the hot leg switchover timing calculation (Ref. 3). This is accomplished by obtaining at least 24 ice samples. Each sample is taken approximately one foot from the top of the ice of each randomly selected ice basket in each ice condenser bay. The SR is modified by a NOTE that allows the boron concentration and pH value obtained from averaging the individual samples' analysis results to satisfy the requirements of the SR. If either the average boron concentration or average pH value is outside their prescribed limit, then entry into ACTION Condition A is required. Sodium tetraborate has been proven effective in maintaining the boron content for long storage periods, and it also enhances the ability of the solution to remove and retain fission product iodine. The high pH is required to enhance the effectiveness of the ice and the melted ice in removing iodine from the containment atmosphere. This pH range also minimizes the occurrence of chloride and caustic stress corrosion on mechanical systems and components exposed to ECCS and Containment Spray System fluids in the recirculation mode of operation. The Frequency of [54] months is intended to be consistent with the expected length of three fuel cycles, and was developed considering these facts:

a. Long term ice storage tests have determined that the chemical composition of the stored ice is extremely stable,

b. There are no normal operating mechanisms that decrease the boron concentration of the stored ice, and pH remains within a 9.0-9.5 range when boron concentrations are above approximately 1200 ppm,

c. Operating experience has demonstrated that meeting the boron concentration and pH requirements has never been a problem, and

d. Someone would have to enter the containment to take the sample, and, if the unit is at power, that person would receive a radiation dose.

SR 3.6.15.6

This SR ensures that a representative sampling of ice baskets, which are relatively thin walled, perforated cylinders, have not been degraded by wear, cracks, corrosion, or other damage. Each ice basket must be raised at least 12 feet for this inspection. The Frequency of 40 months for a visual inspection of the structural soundness of the ice baskets is

Insert F

BASES

SURVEILLANCE REQUIREMENTS (continued)

based on engineering judgment and considers such factors as the thickness of the basket walls relative to corrosion rates expected in their service environment and the results of the long term ice storage testing.

SR 3.6.15.7

This SR ensures that initial ice fill and any subsequent ice additions meet the boron concentration and pH requirements of SR 3.6.15.5. The SR is modified by a NOTE that allows the chemical analysis to be performed on either the liquid or resulting ice of each sodium tetraborate solution prepared. If ice is obtained from offsite sources, then chemical analysis data must be obtained for the ice supplied.

REFERENCES

1. FSAR, Section [6.2].

2. 10 CFR 50, Appendix K.

3. [Westinghouse letter, WAT-D-10686, "Upper Limit Ice Boron Concentration In Safety Analysis"].

4. Topical Report ICUG-001.