Duke Power
A Duke Energy Company

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June 12, 2003

U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

ATTENTION: Document Control Desk

Re: Duke Energy Corporation

Application for License Amendments
Pursuant to 10 CFR 50.4, 10 CFR 50.90, 10 CFR 50.91,
10 CFR 50.92, 10 CFR 51.22

Catawba Nuclear Station Unit 1, 2
USNRC License NPF No. 35 and NPF No. 52
USNRC Docket No. 50-413 and 50-414

McGuire Nuclear Station Unit 1, 2
USNRC License NPF No. 9 and NPF No. 17
USNRC Docket No. 50-369 and 50-370

Amendment to Technical Specification 3.6.12 - Ice Bed
Revise Ice Mass Surveillance Requirements
Supplement and Response to Request for Additional Information

Duke Energy Corporation (Duke) herein submits this supplement to an Application for License Amendment pertaining to Catawba Nuclear Station (CNS) Unit 1 and Unit 2, and McGuire Nuclear Station (MNS) Unit 1 and Unit 2.[1] As supplemented, this Application proposes amendment to Technical Specification (TS) 3.6.12 to incorporate an asymmetrical ice mass distribution and revise the associated surveillance requirements to be consistent with a proposed Westinghouse Owners Group Standard Technical Specification change.

At a public meeting on May 13, 2003, the Ice Condenser Utility Group (ICUG) discussed with NRC staff issues related to the review of Topical Report ICUG-001. ICUG has completed revisions to this topical report and the associated NUREG 1431 (TSTF-429) change request to address these issues.[2,3] ICUG is currently processing submittal of these documents to the NRC. This supplement is to update the

[1] Letter, M. S. Tuckman to U.S. NRC, Amendment to Technical Specification 3.6.12 – Ice Bed, dated January 31, 2003.

[2] Topical Report ICUG-001, Application of the Active Ice Mass Management Concept to the Ice Condenser Ice Mass Technical Specification, Revision 2, dated June 2003.

[3] TSTF-429, Westinghouse Owners Group Standard Technical Specification Change Traveler, Ice Bed Ice Mass Surveillance Requirements, Revision 2.

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Application to include references to these revisions. Therefore, this supplement includes updated TS Bases pages to provide changes consistent with this revision to TSTF-429.

This supplement also includes a response to a NRC staff request for additional information (RAI).[4] The additional information requested by this RAI includes many of the same issues that are addressed by the latest revision to Topical Report ICUG-001.

Several enclosures are included with this supplement for use by the NRC staff to assist in completing the review of the Application.

- Enclosure 1 provides the RAI responses.
- Enclosures 2 and 4 provide updated copies of revised TS BASES pages that Duke plans to implement associated with the proposed amendment for CNS and MNS, respectively.[5]
- Enclosures 3 and 5 provide the current TS BASES pages indicating changes as marked for CNS and MNS, respectively.

Duke has determined that this supplement does not impact the original determination that the requested license amendments do not involve a Significant Safety Hazard, and that these changes are subject to categorical exclusion from Environmental Review.

Duke has identified that this supplement provides the following commitment in addition to those previously identified in the Application.

- Duke Procedures will direct that if an individual basket is determined to contain less stored ice mass than the required safety analysis mean for its Radial Zone, this condition is to be identified in the corrective action program, including initiating an evaluation to identify the cause and correct any deficiencies with associated maintenance practices.

Please direct questions regarding this supplement to M. R. Wilder at (704) 875-5362.

Very truly yours,

M. S. Tuckman

M. S. Tuckman

Enclosures:
1. Responses to Request for Additional Information on Application for License Amendments
2. CNS, Revised TS BASES Pages associated with Proposed Amendment
3. CNS, Marked Changes to Current TS BASES Pages
4. MNS, Revised TS BASES Pages associated with Proposed Amendment
5. MNS, Marked Changes to Current TS BASES Pages

[4] Letter, R. E. Martin to M. S. Tuckman, Request for Additional Information regarding an Application to Amend Ice Bed Ice Mass Surveillance Requirements, dated May 12, 2003.

[5] These BASES changes will be implemented pursuant to 10 CFR 50.59 and do not require NRC staff approval.

XC w/enclosures:

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M. S. Tuckman, affirms that he is the person who subscribed his name to the foregoing statement, and that all the matters and facts set forth herein are true and correct to the best of his knowledge.

M. S. Tuckman

M. S. Tuckman, Executive Vice President

Subscribed and sworn to me: June 12, 2003
Date

Mary P. Nelms
Notary Public

My Commission Expires: JAN 22, 2006
Date

SEAL

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T.K Pasour (Document Control Copy CN-801.01) (CN01EP)
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MNS Master File: 1.3.2.9
ELL (EC05O)
NSRB Support Staff (EC05N)
NCMPA-1
NCEMC
PMPA
SREC

Enclosure 1

Responses to
Request for Additional Information
on Application for License Amendments
Regarding
Technical Specification 3.6.12 – Ice Bed
Ice Mass Surveillance Requirements

Duke Energy Corporation
Catawba Nuclear Station, Units 1 and 2
McGuire Nuclear Station, Units 1 and 2

Responses to Request for Additional Information on Application for License Amendments

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Duke Energy Corporation (Duke) has requested NRC staff review of an Application for License Amendment that request revision to the ice mass surveillance requirements of Technical Specification 3.6.12 for Catawba Nuclear Station (CNS) and McGuire Nuclear Station (MNS).[1] Associated with this review, the NRC staff has requested additional information (RAI) to enable the completion of its review.[2] Documented below is each item of this RAI, followed by Duke's response.

1. Ice Mass Determination Methodology:

The current Catawba Surveillance Requirement (SR) 3.6.12.4 and McGuire 3.6.12.2, and their bases reflect that the method of ice mass determination is by direct weighing of the ice baskets. The proposed revisions include the provision of ice mass determination by direct lifting or alternate techniques. The topical report indicates that direct lifting is the preferred method. The proposed TS implies that the ice mass could be determined in its entirety by alternate techniques with or without stuck baskets. Also, as indicated in the topical report, the details regarding these alternate methods are contained in plant-specific procedures.

Identify the alternate techniques (ICEMAN™ or visual inspection) to be used for Catawba and McGuire. For each of the methods, the NRC staff requires the following information:

a) A discussion of the accuracy and precision of the method in terms of the computer software or physical devices used and their method of application. Provide plant-specific justification for the standard deviation and the assumed method random error to be used for specific operational cycles. Discuss plans for dealing with the following concerns:

   i. At present, there is no limit on how many times the two alternate methods may be used successively to estimate the weight of a given basket or radial zone. Are there any limits? If not, specify the method of determination.

   ii. The proposed TS do not require the weighing of any baskets. Table A-1 of the topical report indicates that estimation techniques will be used for over 80 percent of the baskets in row 9 and over 70 percent of the baskets in row 1, for example. Provide criteria for the proportion of plant-specific mass determination to be performed by each method.

   iii. Provide the information supporting the bias and uncertainty values for meeting the TS minimum weight of 600 lbs per basket criterion.

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[1] Letter, M. S. Tuckman to U.S. NRC, Amendment to Technical Specification 3.6.12 – Ice Bed, dated January 31, 2003.

[2] Letter, R. E. Martin to M. S. Tuckman, Request for Additional Information regarding an Application to Amend Ice Bed Ice Mass Surveillance Requirements, dated May 12, 2003.

Response 1 a):
Topical Report ICUG-001 describes three methods for determining the mass of individual ice baskets:

1. Direct lifting of the basket with a lifting rig utilizing a calibrated load cell,

2. Projection of the basket's expected mass from historical data and calculated sublimation rates (determined using mass data obtained by load cell), and

3. Visual approximation of the basket's mass made from a full-length inspection of the ice basket using a video camera.[3]

All of these methods rely, to some degree, on basket mass data obtained through the use of a load cell device. Methods 2 and 3 were developed to facilitate determining the mass of baskets that cannot be directly lifted due to obstruction or ice build-up around the basket's periphery, a situation that occasionally occurs in some baskets that were initially free to lift. For each of these methods, the uncertainty in the mass determinations must be defined prior to their use in satisfying surveillance requirements for total ice bed mass.

While the need for using an alternate ice mass determination method is limited to those baskets that cannot be lifted, there is no basis for a limit on the successive use of an alternate ice mass determination method. Duke Energy Corporation (Duke) procedure conformance with the standards provided in Topical Report ICUG-001 provides assurance of statistical validity in performing the surveillances associated with ice mass determination using any of the three described methods. The alternate ice mass determination methods rely upon benchmark load cell measurements to determine a statistically valid uncertainty, which inherently limits the use of the alternate methods by requiring a significant number of weighable ice baskets. Additionally, the larger uncertainty associated with the alternate ice mass determination methods, in comparison to direct lifting with a load cell, necessitates actively maintaining additional ice mass in baskets where the alternate method is employed to account for the uncertainty difference. This imposed burden provides an incentive to maintaining baskets free to be lifted in order to minimize the use of alternate ice mass determination methods.

MNS and CNS intend to utilize methods 1 (direct lift with load cell) and 2 (projection using sublimation trends) to determine ice mass in individual baskets in performing the technical specification surveillance. Duke does not currently plan to use method 3 (visual estimation). Because of the relatively free condition of baskets in both the MNS and CNS ice beds, Duke has been successful in obtaining ice mass data with the direct lift method, which has provided both a minimal need for alternate ice mass determination methods and a large historical basket mass database for the use of the projection method. However, Duke plans to continue support of industry development of the visual method. Any future determination by Duke to use the visual estimation method in performing technical specification surveillances will be consistent with the standard described in Section II of Topical Report ICUG-001, and the requirements of 10CFR50.59.

The ice mass projection method will be an option in performing the ice mass surveillances <u>only</u> for those baskets where the condition of the basket is such that the ability to lift the basket with the preferred lifting rig technique is not feasible. As discussed in Topical Report ICUG-001, the

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[3] Topical Report ICUG-001, <u>Application of the Active Ice Mass Management Concept to the Ice Condenser Ice Mass Technical Specification</u>, Revision 2, dated June 2003.

mass of ice in a basket can be reliably predicted using historical sublimation trends, a task facilitated by software applications designed to process large quantities of data. The software primarily used for this purpose at the Duke plants is ICEMAN™. This software is a database-related program (similar to the Microsoft Corporation's Access and Excel software applications) that trends ice basket mass histories and can be utilized to project future ice basket mass based on individual sublimation rates and previous ice basket mass data. The use of this software in providing input to selecting baskets for replenishment, random selection of baskets for performing the technical specification surveillances, and the planned use as an alternate mass determination method are considered nuclear safety related uses. Therefore, to support these safety related uses, Duke maintains documented validation of this software in accordance with the requirements of 10CFR50, Appendix B.

Duke will use the ice mass projection method through implementing the standard described in Section II of Topical Report ICUG-001 into plant procedures that are maintained in accordance with the requirements of 10CFR50, Appendix B.

An example calculation of uncertainty for the ice mass projection method is provided in Section II of Topical Report ICUG-001. This example is consistent with a calculated uncertainty for a Duke Unit, including the data that is used in Table 2-2 of Topical Report ICUG-001. The actual uncertainty of the projection method will vary for each Unit and vary each cycle since this value is recalculated each outage based on new data gained from those baskets lifted with a load cell. Where the ice mass projection method is used to determine compliance with surveillance requirements, the calculated uncertainty is directly subtracted from each basket's projected ice mass value to determine compliance with the requirement of a minimum ice mass of 600 lbs.

b) Provide correlations and data to demonstrate the adequacy of any estimation methods used to predict ice weight for CNS and MNS.

Response 1 b):
As noted in the response to 1 a), the Duke stations intend to utilize the ice mass projection method (when it is required) as an alternate mass determination technique. This will be accomplished through the trending of sublimation histories of each basket in the ice beds of each Unit using the ICEMAN™ program or similar software. The correlations needed to validate this methodology as a viable alternate mass determination technique are described in Section II of Topical Report ICUG-001. These correlations are the comparisons between the ice mass determined by lifting with a load cell and the ice determined by the projection method. As demonstrated in the example in Section II of Topical Report ICUG-001, the differences between these methods is used to calculate the uncertainty of ice mass projection on a Unit and cycle specific basis.

c) Describe the processes that will ensure that once the adequacy of an alternate method is determined, it will continue to be maintained.

Response 1 c):
As noted in the topical report, at the end of each cycle as-found basket mass data is obtained on ice baskets in the ice bed to accommodate AIMM methodology and determine outage replenishment scope. This new data is incorporated into the ICEMAN™ database at the end of each outage, which adjusts the future sublimation patterns for the baskets in that ice bed, and also adjusts the uncertainty value to be applied to any baskets in that bed whose mass must be

projected at the start of the next outage. This calculation and database revision process is performed per plant procedures in accordance with 10CFR50, Appendix B.

d) Provide a discussion of the training and qualifications of the personnel that will perform the inspections or estimations.

__Response 1 d):__
The ice basket mass determination procedures used at Duke, both primary and alternate techniques, involve properly trained and qualified personnel.

The primary technique, direct lifting using a load cell, is performed by maintenance crews that are trained in the use of the lifting rig/load cell. Engineering personnel provide technical oversight during this process to ensure the accuracy of data collection. Ice mass determination via direct lifting with a load cell is performed per procedures in accordance with 10CFR50, Appendix B.

The alternate mass determination methodology currently planned to be used at MNS and CNS, the ICEMAN™ projection technique, requires data entry and standard statistics calculation performance. Engineering personnel provide technical oversight of the data entry and statistics calculations. These processes are guided by plant procedures in accordance with 10CFR50, Appendix B.

e) Identify any areas where the plant-specific application differs from the ICUG topical report.

__Response 1 e):__
The two areas in the Duke application that differ from the standard described by the Topical Report ICUG-001 are:

1. The Radial Zones for the Duke plants are different from the standard. In both of the MNS and CNS ice beds, Radial Zone A consists of only two rows (8 and 9) as opposed to the standard, which describes a three-row Radial Zone A (rows 7, 8, and 9). In addition, at the Duke plants, row 7 is incorporated into Radial Zone B, making it a four-row zone (rows 4, 5, 6, and 7). Radial Zone C, containing rows 1, 2, and 3, are the same as the standard for the Duke plants.
2. The minimum required total ice mass for the Radial Zones in the Duke application is asymmetric (i.e., the total mass requirement for Radial Zone A differs from Radial Zones B and C). In the standard, all three Radial Zones have the same minimum total mass requirement, making it uniform across the ice bed.

f) Provide a sample calculation showing how individual ice basket weight data, both measured and estimated, will be processed to determine compliance with the TS limit values.

Response 1 f):
Duke plans to implement the methodology described in Section III of Topical Report ICUG-001, which describes in detail how the mass of ice in each Radial Zone and the mass of the entire ice bed is determined from a sampled group of baskets with the required 95% confidence level. An example of applying this methodology has been included in Section III of Topical Report ICUG-001 to demonstrate how measured and estimated ice mass values will be processed to determine compliance with the surveillance requirements. Duke will implement this methodology into plant procedures and calculations that are maintained in accordance with the requirements of 10CFR50, Appendix B.

2. Asymmetrical ice mass distribution in three radial zones of the ice bed:

The current ice mass determination method is designed to weigh representative samples of 6 baskets from each of the 24 ice condenser bays, for a total of 144 weighed baskets. The proposed changes use random sampling to select individual baskets. The random sampling includes dividing the ice bed into 3 radial zones and sampling at least 30 baskets from each zone (for a total of 90 baskets) from the entire ice bed. Duke's definition of these 3 radial zones is different from the one proposed in the ICUG topical report and TSTF-429.

Referring to the following statements regarding the asymmetrical ice mass distribution, specific operating characteristics of the ice condensers and Duke's maintenance practices, provide the plant-specific information for Catawba and McGuire:

a. Reference 1, Enclosure 11, Page 3, Paragraph 2, under Asymmetric Mass Distribution, states that:

   "Duke has evaluated the specific operating characteristics of each of the Catawba and McGuire ice condensers to determine an effective grouping of these rows and ice mass acceptance criterion for each zone."

   What are the specific operating characteristics that are evaluated, and how are they aligned with the grouping of radial zones for Catawba and McGuire?

Response 2 a):
The operating characteristics at MNS and CNS referred to in Duke's amendment request are the sublimation patterns of each of the four ice beds. The use of ICEMAN™ software over many cycles has allowed considerable basket mass data to be accumulated. This data has been evaluated to select a grouping of radial rows that will best allow an asymmetric ice mass profile to be applied to maximize the service life of the stored ice in the ice bed. The assessment evaluated the general sublimation trends of the radial rows to provide groupings that maintain each ice basket as representative of its radial zone at these plants consistent with the radial zone concept described in Section I of Topical Report ICUG-001. This approach enhances the statistical stratified sample that provides accuracy in performing the technical specification surveillances.

b. Reference 1, Enclosure 11, Page 4, Paragraph 4, states that:

   "Asymmetrical distribution provides an ice mass acceptance criterion for each zone that takes the greatest credit in the low sublimation zone, and the least in the highest sublimation zone. Therefore, containment response analysis is aligned with operating characteristics, and the increased service life of the stored ice in high sublimation baskets results in less wastage of stored ice."

Explain how the operating characteristics are used in the containment response analysis.

Response 2 b):
The GOTHIC containment response analysis model for MNS and CNS divides the ice mass in the ice bed into elements of various sizes and cross-sections. These elements can be nodalized in many different ways, providing the opportunity to refine the mass profile in different sections of the ice bed and determine the effect of those changes on the DBA containment response. To support Duke's asymmetric load profile license amendment request, the model was revised to reduce the mass present in Radial Zone A (rows 8 and 9), and increase the mass accordingly in Radial Zones B and C.

The rationale for this adjustment, which did not adversely affect the DBA containment response for either plant, was that the baskets in Radial Zone A reside in the highest sublimation areas of the ice bed and therefore are subject to the most rigorous maintenance. By reducing the needed total mass in this radial zone, the "service life" of the stored ice in individual baskets of this zone is increased, which reduces the maintenance frequency of these baskets. Reducing basket maintenance frequency (i.e., emptying and replenishment) also reduces the chance of basket damage, and lessens the propensity of these baskets to become stuck.

The ice mass shifted from Radial Zone A was added uniformly to the other two radial zones, which are in areas of less sublimation and therefore retain their mass longer. Since the baskets in these zones are less frequently replenished they rarely become stuck, so ice mass assessments are highly accurate.

c. Reference 1, Enclosure 11, Page 5, Paragraph 2, states that:

"Sublimation allowances will continue to be managed by the CNS and MNS maintenance programs. Duke's utilization of the data from previous performance of TS required ice mass inspections, and additional inspection beyond these requirements, has enabled the development of a maintenance program that is reliably predictive regarding the specific operating characteristics of each of the ice beds on an individual basket basis."

Provide details on the Catawba and McGuire maintenance programs, including additional inspections beyond the TS requirements.

Response 2 c):
Details regarding Active Ice Mass Management practices are given in Section I of Topical Report ICUG-001. In order to perform appropriate replenishment activities on the ice bed each outage, the number of baskets needing to be serviced must be identified. Replenishment "triggers" vary from unit to unit due to variations in specific sublimation rates, but in all four of Duke's ice beds the as-found ice mass in each basket of the bed must be assessed prior to assigning replenishment scope. This is performed **in addition** to any statistically sampled basket mass measurements needed for showing compliance with the technical specification surveillance requirements.

As shown in Figure 1-2 of the topical report, there are a significant number of baskets that will not need ice replenishment every outage (such as those in rows 1-6). However, the current mass of ice in these baskets must still be determined in order to predict when they will need replenishment in the future. This process (assigning replenishment scope to the current and future outages based on current basket mass and known sublimation trends) is an active management process, requiring specific knowledge of the ice bed's sublimation behavior patterns. In most cases, each individual basket in the ice bed has a known sublimation behavior pattern associated with it, based on its specific location. Upon determining the as-found ice mass for a basket in the bed, plant personnel then compare that value to the required safety analysis mean value and apply that basket's sublimation trend to project its mass forward through the coming cycle. Any individual basket's ice mass that is projected to sublimate to or below the safety analysis mean mass value is serviced during the current outage. This is how AIMM practice maintains the ice mass in each individual basket above the required safety analysis mean.

3. Minimum Ice Mass Requirement for Individual Ice Baskets:

Referring to the proposed SR 3.6.12.4, Insert A, and its associated Bases, provide the following:

a. Details on maintenance practices for the plant-specific active mass management to the "safety analysis mean" for individual baskets.

Response 3 a):
The details regarding the Active Ice Mass Management practices at MNS and CNS, including the managing of individual baskets to the safety analysis mean mass, are described in the response to 2 c) above.

b. Clarify the statement underlined below:

"If any ice basket is identified to be deficient with respect to these ice mass values, this condition is to be addressed in the Licensee's corrective action program. This alone is not considered a significant condition adverse to quality as long as the ice mass requirements of SR 3.6.12.4 and SR 3.6.12.5 remain satisfied."

Under the maintenance procedures, what are the corrective actions and reporting requirements to be followed even though this alone is not a TS violation? In Duke's Quality Assurance Program description (reference 5), the corrective action program is associated with conditions that are adverse to quality. Please discuss the comparable processes and criteria in the Quality Assurance Program that will apply to treatment of this issue in the Licensee's corrective action program if the condition is not considered to be adverse to quality.

Response 3 b):
Upon implementation of the proposed license amendment, CNS's and MNS's licensing basis will describe that the ice mass in each basket is to be managed above the required safety analysis mean. This will be incorporated into the licensing basis through an Updated Final Safety Analysis Report revision, which references Topical Report ICUG-001. Reinforcing this will be the description in the revised Technical Specification Bases.

Duke Procedures will direct that if an individual basket is determined to contain less stored ice mass than the required safety analysis mean for its Radial Zone, this condition is to be identified in the corrective action program, including initiating an evaluation to identify the cause and correct any deficiencies with associated maintenance practices. This condition would be considered a "condition adverse to quality." Consistent with Duke's corrective action program, "apparent cause" and "extent of condition" evaluations would be completed. The "extent of condition" evaluation of these maintenance practices would include consideration of ice bed compliance with technical specification requirements. This evaluation would provide the necessary input for appropriate initiation of any needed evaluation for determination of reportability per the criteria of 10CFR50.72 and 10CFR50.73.

If an individual basket is determined to contain less stored ice mass than the technical specification required 600 pounds, this condition would be in violation of the proposed surveillance requirements. Therefore, as a technical specification prohibited condition, this occurrence would be reportable per the requirements of 10CFR50.73. This condition would be considered a "significant condition adverse to quality." Duke procedures associated with the corrective action program direct that this occurrence would be identified in Duke's corrective action program, investigated, and a Duke internal report prepared which evaluates the occurrence and provides recommendations to prevent recurrence consistent with the requirements of 10CFR50, Appendix B. A licensee event report would be required to be prepared and submitted to the NRC describing the occurrence, cause, corrective actions to prevent recurrence, and safety significance per the requirements of 10CFR50.73.

Based on discussion between the NRC and the ICUG during a public meeting on May 13, 2003, ICUG has initiated a revision to TSTF-429 revising the Technical Specification Bases description of the surveillance requirements associated with ice mass determination.[4] Consistent with this revision, planned revisions to Technical Specification Bases for CNS and MNS are being submitted along with this RAI Response to more specifically describe corrective action program interface.

[4] TSTF-429, Westinghouse Owners Group Standard Technical Specification Change Traveler, Ice Bed Ice Mass Surveillance Requirements, Revision 2.

Enclosure 2

Catawba Nuclear Station
Units 1 & 2
Revised Technical Specification 3.6.12 BASES
Associated with Proposed Amendment
(For Information Only)

pages: B 3.6.12-1
B 3.6.12-2
B 3.6.12-3
B 3.6.12-4
B 3.6.12-5
B 3.6.12-6
B 3.6.12-7
B 3.6.12-8
B 3.6.12-9
B 3.6.12-10
B 3.6.12-11

B 3.6 CONTAINMENT SYSTEMS

B 3.6.12 Ice Bed

BASES

BACKGROUND

The ice bed consists of a minimum of 2,132,000 lbs of ice stored within the ice condenser. 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

BASES

BACKGROUND (continued)

pressure and temperature buildup in containment. A divider barrier (i.e., operating deck and extensions thereof) 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.

It is important for ice to exist in the ice baskets, the ice to be appropriately 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.

BASES

BACKGROUND (continued)

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

a. Loss of ice by melting or sublimation; and

b. Obstruction of flow passages through the ice bed due to buildup of 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, RHR 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, RHR 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

BASES

APPLICABLE SAFETY ANALYSES (continued)

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 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 (Ref. 3).

LCO

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 the blowdown phase and long term phase of a DBA, thereby limiting containment air temperature and pressure. The chemical content and pH of the stored 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. The limits on boron concentration and pH of the ice are associated with containment sump pH ranging between 7.5 and 9.3 inclusive following the design basis LOCA.

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.

BASES

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 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 3.6.12.1

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.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.6.12.2

This SR ensures that initial ice fill and any subsequent ice additions meet the boron concentration and pH requirements of SR 3.6.12.7. 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.

SR 3.6.12.3

This SR ensures that the air/steam 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 rather 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:

a. between ice baskets, and

b. past lattice frames and wall panels.

Due to a significantly larger flow area in the regions of the upper deck grating and the lower inlet plenum support structures and turning vanes, it would require a gross buildup of ice on these structures to obtain a degradation in air/steam flow. Therefore, these structures are excluded as part of a flow channel for application of the 15 percent blockage criteria. Plant and industry experience have shown that removal of ice from the excluded structures during the refueling outage is sufficient to ensure they remain operable throughout the operating cycle. Thus,

BASES

SURVEILLANCE REQUIREMENTS (continued)

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 on 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 not a 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.

Activities that have a potential for significant degradation of flow channels should be limited to outage periods. Performance of this SR following completion of these activities assures the ice bed is in an acceptable condition for the duration of the operating cycle.

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, and can be brushed off with the open hand.

SR 3.6.12.4

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 8, and 9 (innermost rows adjacent to the Crane Wall), Radial Zone B consists of baskets located in rows 4, 5, 6, and 7 (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).

BASES

SURVEILLANCE REQUIREMENTS (continued)

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. 5.

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 3.6.12.5, 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.

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.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.6.12.5

Verifying that each selected sample basket from SR 3.6.12.4 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. 5 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 3.6.12.4 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.

As documented in Ref. 5, 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 750 lbs for Radial Zone A, 1196 lbs for Radial Zone B, and 1196 lbs for Radial Zone C. If a basket sublimates below the safety analysis mean value, this instance is identified within the plant's corrective action program, including evaluating maintenance practices to identify the cause and correct any deficiencies. These maintenance practices provide defense in depth beyond compliance with the ice bed surveillance requirements by limiting the occurrence of individual baskets with ice mass less than the required safety analysis mean.

SR 3.6.12.6

This SR ensures that a representative sampling of accessible portions of ice baskets, which are relatively thin walled, perforated cylinders, have not been degraded by wear, cracks, corrosion, or other damage. 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. The Frequency of 40 months for a visual inspection of the structural soundness of the ice baskets is 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.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.6.12.7

Verifying the chemical composition of the stored ice ensures that the stored ice has a boron concentration ≥ 1800 ppm and ≤ 2330 ppm as sodium tetraborate and a high pH, ≥ 9.0 and ≤ 9.5 at 25°C, 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 LOCA environment, while the maximum boron concentration is used as the bounding value in the hot leg switchover timing calculation (Ref. 4). 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 significantly change 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; and

c. Operating experience has demonstrated that meeting the boron concentration and pH requirements has not been a problem.

BASES

REFERENCES

1. UFSAR, Section 6.2.
2. 10 CFR 50, Appendix K.
3. 10 CFR 50.36, Technical Specifications, (c)(2)(ii).
4. UFSAR, Section 6.3.3.
5. Topical Report ICUG-001.

Enclosure 3

Catawba Nuclear Station
Units 1 & 2
Marked Changes
Technical Specification 3.6.12 BASES
(For Information Only)

pages: B 3.6.12-1
B 3.6.12-2
B 3.6.12-3
B 3.6.12-4
B 3.6.12-5
B 3.6.12-6
B 3.6.12-7
B 3.6.12-8
B 3.6.12-9

B 3.6 CONTAINMENT SYSTEMS

B 3.6.12 Ice Bed

BASES

BACKGROUND

The ice bed consists of ~~over 2,330,856 lb~~ a minimum of 2,132,000 lbs 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

BASES

BACKGROUND (continued)

pressure and temperature buildup in containment. A divider barrier separates the upper and lower compartments and ensures that the steam is directed into the ice condenser.

(i.e., operating deck and extensions thereof)

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

,

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.

BASES

BACKGROUND (continued)

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

a. Loss of ice by melting or sublimation; and

b. Obstruction of flow passages through the ice bed due to buildup of 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, RHR 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, RHR 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

BASES

APPLICABLE SAFETY ANALYSES (continued)

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 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 (Ref. 3).

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. The limits on boron concentration and pH of the ice are associated with containment sump pH ranging between 7.5 and 9.3 inclusive following the design basis LOCA.

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.

BASES

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 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 3.6.12.1

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.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.6.12.2

This SR ensures that initial ice fill and any subsequent ice additions meet the boron concentration and pH requirements of SR 3.6.12.7. 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.

SR 3.6.12.3

This SR ensures that the air/steam 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 rather 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:

a. between ice baskets, and

b. past lattice frames and wall panels.

Due to a significantly larger flow area in the regions of the upper deck grating and the lower inlet plenum support structures and turning vanes, it would require a gross buildup of ice on these structures to obtain a degradation in air/steam flow. Therefore, these structures are excluded as part of a flow channel for application of the 15 percent blockage criteria. Plant and industry experience have shown that removal of ice from the excluded structures during the refueling outage is sufficient to ensure they remain operable throughout the operating cycle. Thus,

BASES

SURVEILLANCE REQUIREMENTS (continued)

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 on 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 not a 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.

Activities that have a potential for significant degradation of flow channels should be limited to outage periods. Performance of this SR following completion of these activities assures the ice bed is in an acceptable condition for the duration of the operating cycle.

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, and can be brushed off with the open hand.

INSERT A

SR 3.6.12.4

~~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.~~

BASES

SURVEILLANCE REQUIREMENTS (continued)

INSERT A

~~If a basket is found to contain < 1199 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 ≥ 1199 lb at a 95% confidence level.~~

~~Weighing 20 additional baskets from the same bay in the event a Surveillance reveals that a single basket contains < 1199 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 18 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 18 month Frequency, the weight requirements are maintained with no significant degradation between surveillances.~~

SR 3.6.12.5

INSERT B

~~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 18 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 18 month Frequency, the weight requirements are maintained with no significant degradation between surveillances.~~

SR 3.6.12.6

INSERT C

This SR ensures that a representative sampling of accessible portions 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 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.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.6.12.7

Verifying the chemical composition of the stored ice ensures that the stored ice has a boron concentration $\geq$ 1800 ppm and $\leq$ 2330 ppm as sodium tetraborate and a high pH, $\geq$ 9.0 and $\leq$ 9.5 at 25°C, 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 LOCA environment, while the maximum boron concentration is used as the bounding value in the hot leg switchover timing calculation (Ref. 4). 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 significantly change 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; and

c. Operating experience has demonstrated that meeting the boron concentration and pH requirements has not been a problem.

BASES

REFERENCES

1. UFSAR, Section 6.2.
2. 10 CFR 50, Appendix K.
3. 10 CFR 50.36, Technical Specifications, (c)(2)(ii).
4. UFSAR, Section 6.3.3.
5. Topical Report ICUG-001.

INSERT A

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 8, and 9 (innermost rows adjacent to the Crane Wall), Radial Zone B consists of baskets located in rows 4, 5, 6, and 7 (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. 5.

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 3.6.12.5, 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.

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 B

Verifying that each selected sample basket from SR 3.6.12.4 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. 5 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 3.6.12.4 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.

As documented in Ref. 5, 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 750 lbs for Radial Zone A, 1196 lbs for Radial Zone B, and 1196 lbs for Radial Zone C. If a basket sublimates below the safety analysis mean value, this instance is identified within the plant's corrective action program, including evaluating maintenance practices to identify the cause and correct any deficiencies. These maintenance practices provide defense in depth beyond compliance with the ice bed surveillance requirements by limiting the occurrence of individual baskets with ice mass less than the required safety analysis mean.

INSERT C

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.

Enclosure 4

McGuire Nuclear Station
Units 1 & 2
Revised Technical Specification 3.6.12 BASES
Associated with Proposed Amendment
(For Information Only)

pages: B 3.6.12-1
B 3.6.12-2
B 3.6.12-3
B 3.6.12-4
B 3.6.12-5
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B 3.6.12-7
B 3.6.12-8
B 3.6.12-9
B 3.6.12-10

B 3.6 CONTAINMENT SYSTEMS

B 3.6.12 Ice Bed

BASES

BACKGROUND

The ice bed consists of a minimum of 1,890,000 lbs of ice stored within the ice condenser. 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) separates the upper and lower compartments and ensures that the steam is directed into the ice condenser.

BACKGROUND (continued)

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.

It is important for ice to exist in the ice baskets, the ice to be appropriately 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

b. Obstruction of flow passages through the ice bed due to buildup of ice.

Both of these degrading phenomena are reduced by minimizing air leakage into and out of the ice condenser.

BACKGROUND (continued)

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, RHR 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, RHR 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 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 (Ref. 3).

BASES

LCO

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 the blowdown phase and long term phase of a DBA, thereby limiting containment air temperature and pressure. The chemical content and pH of the stored 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 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 3.6.12.1

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 3.6.12.2

This SR ensures that initial ice fill and any subsequent ice additions meet the boron concentration and pH requirements of SR 3.6.12.7. 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.

SR 3.6.12.3

This SR ensures that the air/steam 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 rather 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 form 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:

SURVEILLANCE REQUIREMENTS (continued)

a. Between ice baskets, and

b. Past lattice frames and wall panels.

Due to a significantly larger flow area in the regions of the upper deck grating and the lower inlet plenum support structures and turning vanes, it would require a gross buildup of ice on there structures to obtain a degradation in air/steam flow. Therefore, these structures are excluded as part of a flow channel for application of the 15 percent blockage criteria. Plant and industry experience have shown that removal of ice from the excluded structures during the refueling outage is sufficient to ensure they remain operable throughout the operating cycle. Thus, 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 on 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 not a 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 provided measures to clear the ice basket support platform following maintenance activities of any accumulation of ice that could block flow areas.

Activities that have a potential for significant degradation of flow channels should be limited to outage periods. Performance of this SR following completion of these maintenance activities assures the ice bed is in an acceptable condition for the duration of the operating cycle.

Frost buildup or lose 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, and can be brushed off with the open hand.

SURVEILLANCE REQUIREMENTS (continued)

SR 3.6.12.4

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 8, and 9 (innermost rows adjacent to the Crane Wall), Radial Zone B consists of baskets located in rows 4, 5, 6, and 7 (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. 5.

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 3.6.12.5, are the minimum requirements for

SURVEILLANCE REQUIREMENTS (continued)

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.

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.

SR 3.6.12.5

Verifying that each selected sample basket from SR 3.6.12.4 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. 5 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 3.6.12.4 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.

As documented in Ref. 5, 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 725 lbs for Radial Zone A, 1043 lbs for Radial Zone B, and 1043 lbs for Radial Zone C. If a basket sublimates below the safety analysis mean value, this instance is identified within the plant's corrective action program, including evaluating maintenance practices to identify the cause and correct any deficiencies. These maintenance practices provide defense in depth beyond compliance with the ice bed surveillance requirements by limiting the occurrence of individual baskets with ice mass less than the required safety analysis mean.

SURVEILLANCE REQUIREMENTS (continued)

SR 3.6.12.6

This SR ensures that a representative sampling of accessible portions of ice baskets, which are relatively thin walled, perforated cylinders, have not been degraded by wear, cracks, corrosion, or other damage. 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. The Frequency of 40 months for a visual inspection of the structural soundness of the ice baskets is 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 3.6.12.7

Verifying the chemical composition of the stored ice ensures that the stored ice has a boron concentration ≥ 1800 ppm and ≤ 2330 ppm as sodium tetraborate and a high pH, ≥ 9.0 and ≤ 9.5 at 20°C, 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 LOCA environment, while the maximum boron concentration is used as a bounding value in the hot leg switchover timing calculation (Ref. 4). 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;

SURVEILLANCE REQUIREMENTS (continued)

b. There are no normal operating mechanisms that significantly change the boron concentration of the stored ice, and pH remains within a 9.0 – 9.5 range when boron concentrations are above approximately 1200 pm; and

c. Operating experience has demonstrated that meeting the boron concentration and pH requirements has not been a problem.

REFERENCES

1. UFSAR, Section 6.2.
2. 10 CFR 50, Appendix K.
3. 10 CFR 50.36, Technical Specifications, (c)(2)(ii).
4. UFSAR, Section 6.3.3.10.
5. Topical Report ICUG-001.

Enclosure 5

McGuire Nuclear Station
Units 1 & 2
Marked Changes
Technical Specification 3.6.12 BASES
(For Information Only)

pages:	B 3.6.12-1
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	B 3.6.12-7
	B 3.6.12-8

B 3.6 CONTAINMENT SYSTEMS

B 3.6.12 Ice Bed

a minimum of 1,890,000 lbs

BASES

BACKGROUND

The

The ice bed consists of ~~over 2,099,790 lb~~ of ice stored ~~in 1944 baskets~~ within the ice condenser. ~~Its~~ primary purpose 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.

of the ice bed

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

(i.e., operating deck and extensions thereof)

BACKGROUND (continued)

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

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

b. Obstruction of flow passages through the ice bed due to buildup of ice.

Both of these degrading phenomena are reduced by minimizing air leakage into and out of the ice condenser.

BACKGROUND (continued)

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, RHR 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, RHR 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 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 (Ref. 3).

BASES

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 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 3.6.12.1

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.

INSERT A

~~SR 3.6.12.2~~

~~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 < 1081 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 ≥ 1081 lb at a 95% confidence level.~~

~~Weighing 20 additional baskets from the same bay in the event a Surveillance reveals that a single basket contains < 1081 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.~~

BASES

SURVEILLANCE REQUIREMENTS (continued)

INSERT B

~~SR 3.6.12.3~~

~~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 3.6.12.2 ~~SR 3.6.12.4~~

This SR ensures that initial ice fill and any subsequent ice additions meet the boron concentration and pH requirements of SR 3.6.12.7. 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.

SR 3.6.12.3 ~~SR 3.6.12.5~~

This SR ensures that the air/steam 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 rather 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 ~~slow~~ flow blockage does not exceed the allowed 15 percent, the visual inspection must ~~e~~ 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 form 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:

SURVEILLANCE REQUIREMENTS (continued)

a. Between ice baskets, and

b. Past lattice frames and wall panels.

Due to a significantly larger flow area in the regions of the upper deck grating and the lower inlet plenum support structures and turning vanes, it would require a gross buildup of ice on there structures to obtain a degradation in air/steam flow. Therefore, these structures are excluded as part of a flow channel for application of the 15 percent blockage criteria. Plant and industry experience have shown that removal of ice from the excluded structures during the refueling outage is sufficient to ensure they remain operable throughout the operating cycle. Thus, 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 on 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 not a 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 provided measures to clear the ice basket support platform following maintenance activities of any accumulation of ice that could block flow areas.

Activities that have a potential for significant degradation of flow channels should be limited to outage periods. Performance of this SR following completion of these maintenance activities assures the ice bed is in an acceptable condition for the duration of the operating cycle.

Frost buildup or lose 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, and can be brushed off with the open hand.

SR 3.6.12.6

This SR ensures that a representative sampling of accessible portions 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

INSERT C →

SURVEILLANCE REQUIREMENTS (continued)

Frequency of 40 months for a visual inspection of the structural soundness of the ice baskets is 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 3.6.12.7

Verifying the chemical composition of the stored ice ensures that the stored ice has a boron concentration ≥ 1800 ppm and ≤ 2330 ppm as sodium tetraborate and a high pH, ≥ 9.0 and ≤ 9.5 at 20°C, 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 LOCA environment, while the maximum boron concentration is used as a bounding value in the hot leg switchover timing calculation (Ref. 4). 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 significantly change the boron concentration of the stored ice, and pH remains within a 9.0 – 9.5 range when boron concentrations are above approximately 1200 pm; and

c. Operating experience has demonstrated that meeting the boron concentration and pH requirements has not been a problem.

REFERENCES

1. UFSAR, Section 6.2.
2. 10 CFR 50, Appendix K.
3. 10 CFR 50.36, Technical Specifications, (c)(2)(ii).
4. UFSAR, Section 6.3.3.10.
5. Topical Report ICUG-001.

INSERT A

SR 3.6.12.4

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 8, and 9 (innermost rows adjacent to the Crane Wall), Radial Zone B consists of baskets located in rows 4, 5, 6, and 7 (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. 5.

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 3.6.12.5, 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.

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 B

SR 3.6.12.5

Verifying that each selected sample basket from SR 3.6.12.4 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. 5 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 3.6.12.4 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.

As documented in Ref. 5, 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 725 lbs for Radial Zone A, 1043 lbs for Radial Zone B, and 1043 lbs for Radial Zone C. If a basket sublimates below the safety analysis mean value, this instance is identified within the plant's corrective action program, including evaluating maintenance practices to identify the cause and correct any deficiencies. These maintenance practices provide defense in depth beyond compliance with the ice bed surveillance requirements by limiting the occurrence of individual baskets with ice mass less than the required safety analysis mean.

INSERT C

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.