Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

JAN 3 1 2000

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Gentlemen:

In the matter of) Docket No. 50-390
Tennessee Valley Authority)

WATTS BAR NUCLEAR PLANT (WBN) UNIT 1 - TECHNICAL SPECIFICATION (TS) CHANGE NO. 98-014 - ICE BED FLOW BLOCKAGE SURVEILLANCE REQUIREMENT 3.6.11.4 - RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)

Reference: NRC letter to TVA dated November 18, 1999, "Request for Additional Information on Clarification of Ice Condenser Flow Channel Inspection Requirements (TAC NO. MA4295)"

Enclosures 1 and 2 to this letter provide TVA's responses to the additional information requested in the referenced letter. Enclosure 3 provides revised pages to the subject amendment request. This information has been reviewed by plant representatives of the Ice Condenser Mini-Group (ICMG). If you have any questions about this response, please telephone me at (423) 365-1824.

Sincerely,

P. L. Pace
Licensing and Industry Affairs Manager

Enclosures
cc: See page 2

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TVA Responses to NRC Request for Additional Information on Clarification of Ice Condenser Flow Channel Inspection Requirements (TAC NO. MA4295)

NRC QUESTION NO. 1

Technical Specification (TS) Bases SR 3.6.15.4 state that 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. Explain how a 95 percent confidence level can be obtained by a visual inspection of 33 percent of flow channels.

TVA RESPONSE:

The WBN proposed change to the ice condenser flow blockage visual inspection employs the same performance methodology and acceptance criteria as submitted by TVA's Sequoyah Nuclear Plant (SQN) in their "Technical Specification Change 88-13" initial submittal and revised wording letters of July 27 and October 20, 1988, respectively. The SQN proposed change for their U1/U2 SR 4.6.5.1.b stated, "Verify, by visual inspection . . . is less than or equal to 15-percent blockage of the total flow area in each bay, with a 95-percent level of confidence." NRC conveyed its acceptance of the SQN proposed change in their letter, "Containment Ice Condenser Surveillance (TAC R00417, R00418) (TS 88-13) Sequoyah Nuclear Plant, Units 1 and 2," to TVA dated January 30, 1989.

The proposed and accepted methodology, including the statistical basis for its 95 percent level of confidence, was developed by Westinghouse and provided to SQN in Westinghouse letter, "Ice Condenser Surveillance Techniques," dated June 23, 1988. The results of the Westinghouse calculations to provide the acceptance criteria for surveillance of ice condenser flow passages presented below are for the following conditions:

1. One-third of the flow passages will be randomly selected for surveillance.

2. The flow passages selected for surveillance will be examined for ice blockage and the percent of blockage in each passage estimated. The blockage of the ice passage will be listed as the number of flow passages that have 0, 25, 50, 75, and 100 percent blockage.

3. Based on the total percent of ice blockage in these passages in this sample, the criterion for acceptance is that the total ice blockage in the passages must be less than 15 percent.

The mean proportion, variance and upper bound of all of the possible combinations of blockage were calculated. The mean proportion of the sample that will exceed the allowable 15 percent acceptance limit was determined for each combination as well as the mean number that would be calculated for each combination of failures. The results of these calculations are provided in five tables as described below:

1. All the combinations of 25, 50, and 75 percent blocked passages with no passages having 100 percent blockage.

2. All the combinations of 25, 50, and 75 percent blocked passages with one passage having 100 percent blockage.

3. All the combinations of 25, 50, and 75 percent blocked passages with two passages having 100 percent blockage.

4. All the combinations of 25, 50, and 75 percent blocked passages with three passages having 100 percent blockage.

5. All the combinations of 25, 50, and 75 percent blocked passages with four or five passages having 100 percent blockage.

Methodology

The mean proportion, p′, of blockage over the sample is 0.0 times the proportion with 0 blockage (P0) + 0.25 times the proportion with 25 percent blockage (P1) + 0.50 times the proportion with 50 percent blockage (P2) + 0.75 times the proportion with 75 percent blockage (P3) + the proportion with 100 percent blockage (P4), or

$$p' = 0.25(P1) + 0.50(P2) + 0.75(P3) + 1.0(P4)$$

The proportions, P0, P1, P2, P3, and P4 are calculated as the number of flow passages (n_i) in each of the percentile blockage categories divided by the sample size n, or $Pi = n_i/n$.

The variance, s^2, of this sample mean is:

$$s^2 = \frac{(1-n/N)[0.25^2(P1) + 0.50^2(P2) + 0.75^2(P3) + 1.0(P4)] - (p')^2}{(n-1)}$$

where n is the sample size and N is the population size. The sample size for this calculation is 1/3 of the flow passages; with 162 flow passages in each bay (N). Therefore the sample size n is 54.

The 95th percent upper bound on the true mean proportion of the population is:

$$p' + st$$

where t is from the student T tables (1.673, for n=54 and 95%) and s is the standard error (square root of the variance).

Table Usage - Example

For a given bay, tally the number of flow passages from the sample size (54) that have 25, 50, 75, and 100 percent blockage. All others were evaluated as having zero percent blockage. Next, choose the table to be used based on the number of flow passages that were 100 percent blocked. If five or more passages were 100 percent blocked, then the criterion of less than 15 percent total blockage is exceeded for that bay. For samples with four or less passages having 100 percent blockage, next find the number (in the appropriate table) that corresponds to the number of passages with 75 percent blockage. If the number with 75 percent blockage exceeds the numbers listed in the specific table, then the criterion is exceeded. Continue on in this manner for the number that have 50 and 25 percent blockage. As long as the number of any percent blockage does not exceed that allowed by the applicable table, then the criterion of less than 15 percent blockage is satisfied with a 95 percent level of confidence. As a more specific example, suppose the results of a sample inspection for one bay are: 1 passage=100% blocked; 2 passages=75% blocked; 0 passages=50% blocked; and 2 passages=25% blocked. All other passages have zero blockage.

A portion of table 2 is as follows:

25%	50%	75%	100%
.	.	.	.
.	.	.	.
2	7	1	1
0	8	1	1
13	0	2	1
11	1	2	1
9	2	2	1
7	3	2	1
.	.	.	.
.	.	.	.

The applicable row would be the 13, 0, 2, 1 row. Since only 2 passages had 25 percent blockage the acceptance criterion has not been exceeded, and the surveillance indicates that the mean proportion is less than 15 percent blocked.

NRC QUESTION NO. 2

TS Bases SR 3.6.15.4 states that the allowable 15 percent buildup of ice is based on the analysis of the sub-compartment response to a design basis loss-of-coolant accident (LOCA) with partial blockage of the ice condenser flow channels. The analysis did not perform detailed flow area modeling, but lumped the ice condenser bays into six sections. Individual bays are acceptable with greater than 15 percent blockage, as long as 15 percent blockage is not exceeded for any analysis section.

a. Provide a sketch to illustrate the above flow model showing the flow channels, bays, and sections, explain why "the individual bays are acceptable with greater than 15 percent blockage," and justify the conservatism of the model without using the most restrictive flow area for all the bays in a section to determine the flow area for the model.

b. The safety analysis was performed assuming 15 percent blockage for any section. However, the surveillance requirements will be performed in terms of 15 percent of "total flow area," not "for any section." Justify the differences.

c. Given the potential for human error in judging the amount of a blockage and perhaps some frost hardening to ice during a cycle, justify allowing an acceptance criterion with no margin to the analysis assumption of 15 percent blockage.

TVA RESPONSE:

Part a.

Enclosure 2 provides a sketch of the flow channels for any given bay, and a sketch of the TMD bays/sections. See also WBN FSAR Figure 6.7-46.

The Transient Mass Distribution (TMD) model lumped the 24 ice condenser bays into six nodes, where nodes 1 through 6 consisted of 2.75 bays, 3.25 bays, 6.5 bays, 4.5 bays, 3.5 bays, and 3.5 bays, respectively. As this is a nodal analysis lumping several bays per node, a detailed flow channel analysis cannot be performed. However, a conservative Watts Bar specific subcompartment pressurization analysis using the TMD model was performed by Westinghouse, and demonstrated that 15 percent effective flow blockage was acceptable. This analysis used experimentally determined loss coefficients for flow through the ice condenser flow paths. The corresponding average flow area employed in the analysis was assumed to be 85 percent of the total flow area (15 percent blockage assumption) which occurs at a lattice frame elevation. This limiting flow area was assumed to be uniform along the flow passage length, and throughout the ice condenser bays. This reduced flow area was assumed to be permanent throughout the duration of the accident, conservatively neglecting the fact that much of the blockage would be blown out by the high energy flow through the ice condenser passages. As a result of TMD's one-dimensional ice condenser flow path model, the code conservatively neglects the benefits that cross-flow will provide in venting the steam and air around actual blockages in the ice bed.

As stated in NRC's initial issue of NUREG 0847, Safety Evaluation Report (SER) for WBN (June 1982), the TMD code was reviewed by the NRC and found acceptable for calculating the short-term pressure response in subcompartments.

Other conservatisms were included in the TMD analysis. The hypothetical accident was conservatively assumed to be initiated by the instantaneous, double-ended guillotine rupture of one of the main coolant pipes. The break plane was assumed to be completely displaced instantaneously, such that the effective break flow area is twice the main coolant pipe flow area. Mechanistic pipe break technology has demonstrated that a double-ended guillotine break of this piping is highly unlikely. Even if such a break were possible, the displacement of the piping would be limited by pipe whip restraints, which would significantly reduce the magnitude of the release of high energy steam into the lower containment compartment. This conservatism was further compounded by the fact that the calculated mass and energy releases assumed in the analysis were increased by 10 percent. Also, the analysis conservatively neglected the heat removal capability of the structural heat sinks. Hence, this 15 percent blockage analysis provides a conservative basis for defining an acceptable limit of effective flow blockage in the ice condenser.

According to Westinghouse, an acceptable level of blockage is one that meets the 15 percent criterion based upon the TMD lumping method. That is, there can be individual bays with blockage of greater than 15 percent, or even individual channels completely blocked, as long as the highest calculated blockage percentage in any of the lumped ice condenser sections is ≤ 15 percent.

Part b.

Although the restrictions in the TS Bases tied the surveillance to the safety analysis, TVA agrees the proposed acceptance criteria provided in the SR itself (i.e., ≤ 15 percent blockage of the total flow area) is less restrictive than the analysis criteria (i.e., ≤ 15 percent blockage for each safety analysis (TMD) section). Therefore, enclosure 3 provides the applicable revised pages for the subject amendment request.

Part c.

Conservatisms included in the TMD analysis make up for minimal human errors that may occur in evaluating flow channel blockage. See also the responses to questions 3, 4, and 5.

NRC QUESTION NOs. 3, 4, and 5

3. *Describe the method to determine quantitatively the flow blockage by a visual inspection of flow channels.*

4. *Since the accuracy of the flow area examination will depend, in part, on the visual acuity of the examiner and the quality of the light source, please discuss any plans to include requirements relating to these factors in the examination process.*

5. *Describe the criteria used by the flow area examiner to distinguish between frost and ice during the inspection. Also discuss how built-in blockages, such as junction boxes and other blockages, including bags or debris, will be accounted for in determining the blockage percentage.*

TVA RESPONSE:

Each flow passage inspected is examined from above and below the ice bed using an adequate lighting source. Upon visual inspection, the examiner conservatively evaluates blockage in each flow channel in the sample. The blockage value assigned to each flow channel ranges from 0 to 100 percent in increments of 25 percent. The blockage values from the upper and lower inspections are then reviewed and the highest percentage assigned to the flow passage is used for calculation of flow blockage for the bay. Adequacy of lighting sources and examiner visual acuity are determined on a plant specific basis.

WBN has determined that procedures requiring the trained examiner to use high intensity lighting, and to have documented evidence of visual acuity that meets or exceeds the VT-2 requirements specified in ASME Section IX, IWA 2300, "Qualification of Nondestructive Examination Personnel," would be acceptable. Alternate equivalent methods which enable the examiner to evaluate blockage would also be acceptable.

During the inspection, a distinction is made between fixed and loose obstructions. The obstructions classified as loose would blow out of the flow passage during a LOCA. Therefore, loose obstructions are not counted as blockage. Frost is distinguished from ice during the inspection by its refractive, crystalline structure. If a distinction cannot be made between frost versus ice or loose versus fixed obstructions, then the obstruction is classified as ice and treated as blockage. Permanent blockage such as junction boxes located above the top of the ice bed are not counted as blockage since the flow area is much larger in this area than in the flow passage region. Debris or permanent blockage inside the ice bed that cannot be removed should be counted as flow channel blockage. The blockage measured on the 33 percent flow channel sample is compared to Westinghouse criteria to determine if the total flow channel blockage for that bay is within the 15 percent requirement.

NRC QUESTION NO. 6

It is stated in the submittal that during the operating cycle a certain amount of ice sublimates and reforms as frost on the colder surfaces in the ice condenser. Why can't an additional ice blockage be formed from the frost during the 18-month period? Provide bases or operating data to show that no ice can be added to the flow channels during the 18-month operation to assure that the results of the flow channel blockage inspection at the end of a refueling outage will remain valid for the duration of the 18-month surveillance period.

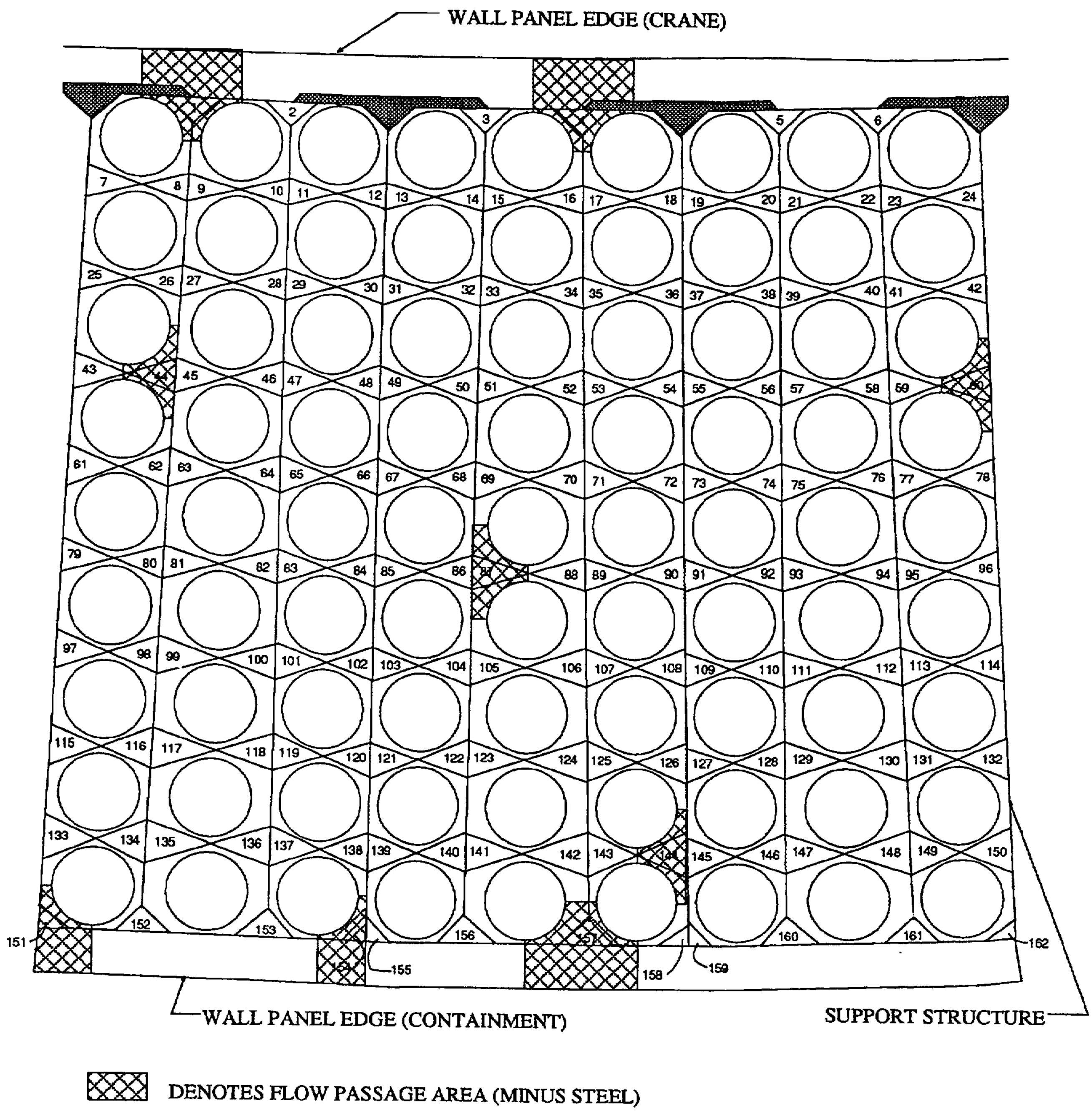
TVA RESPONSE:

Frost formation in the ice condenser is a process where at the coldest surfaces of the ice condenser, the dew point of the air approaches the ice condenser structure surface temperature. The formation of the frost occurs during a vapor to solid crystallization process. The open and fragile lattice crystal form of frost does not impair the ice condenser functional flow of warmer air and steam.

Ice formation occurs during a liquid crystallization to solid ice process. Solid ice is a relatively strong bonded solid with a closed surface. Solid ice may form flow blockage due to the heavy closed structure that will impair the flow of warmer air and steam.

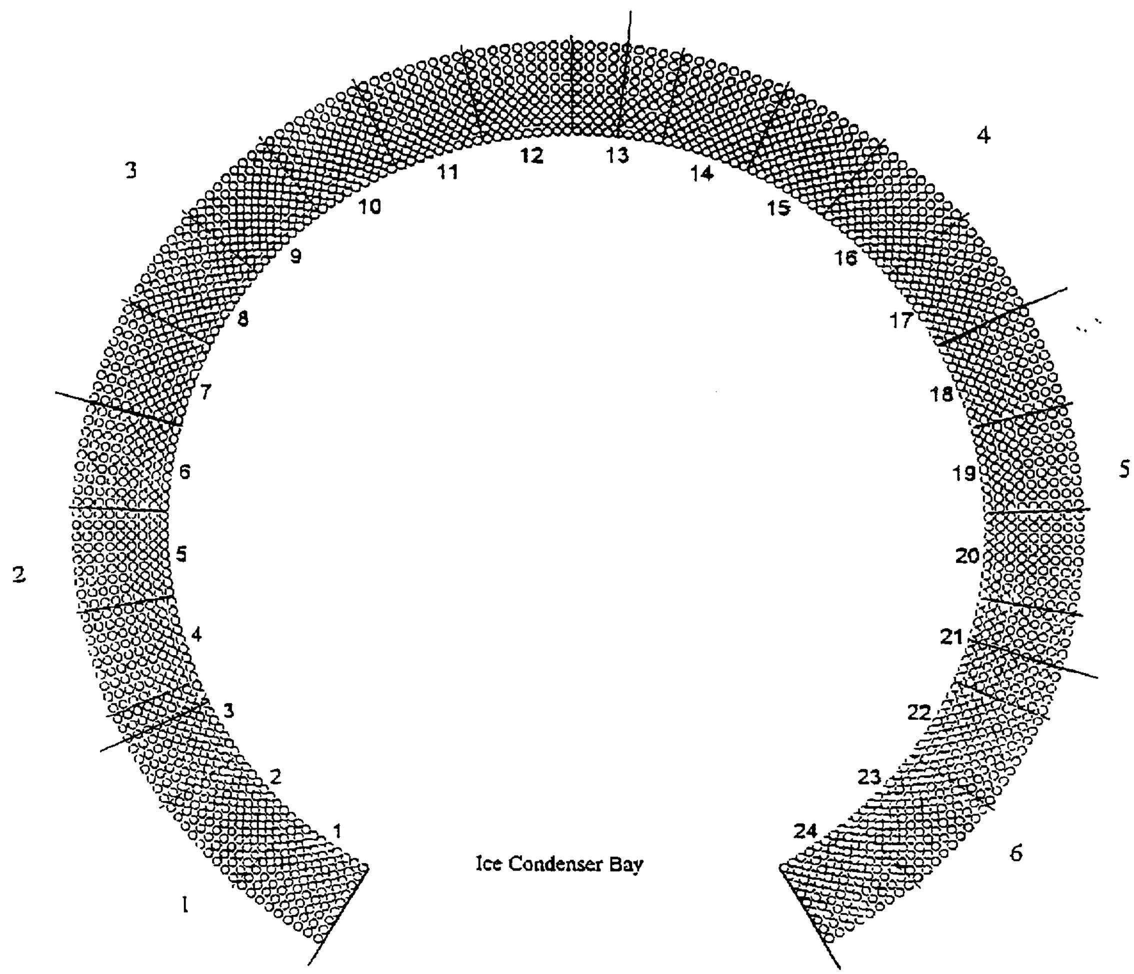
Operating experience has shown that normal operation does not cause frost conversion to ice. Frost conversion to solid ice occurs through two means: a) melting and re-freezing, and b) compacting by physical means. During normal operations, plant Technical Specifications maintain ice bed temperature less than 27°F which prevents the melting/re-freezing mechanism from occurring. Management of ice condenser maintenance activities has limited the potential for compacting frost and/or creating significant flow channel blockage to the refueling outage. The specific post cleaning value is plant specific, based on operating experience and maintenance practices.

FLOW PASSAGE NUMBERING SEQUENCE



TMD MODEL NODES

Node 1: 2.75 Bays	Node 3: 6.50 Bays	Node 5: 3.50 Bays
Node 2: 3.25 Bays	Node 4: 4.50 Bays	Node 6: 3.50 Bays



ENCLOSURE 3

TECH SPEC 3.6.11.4 AMENDMENT REQUEST

REVISED PAGES

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.6.11.2	Verify total weight of stored ice is ≥ 2,403,800 lb by: a. Weighing a representative sample of ≥ 144 ice baskets and verifying each basket contains ≥ 1236 lb of ice; and b. Calculating total weight of stored ice, at a 95% confidence level, using all ice basket weights determined in SR 3.6.11.2.a.	18 months
SR 3.6.11.3	Verify azimuthal distribution of ice at a 95% confidence level by subdividing weights, as determined by SR 3.6.11.2.a, into the following groups:	18 months
a.	Group 1-bays 1 through 8;	
b.	Group 2-bays 9 through 16; and	
c.	Group 3-bays 17 through 24.	
	The average ice weight of the sample baskets in each group from radial rows 1, 2, 4, 6, 8, and 9 shall be ≥ 1236 lb.	
SR 3.6.11.4 See Insert A	~~Verify, by visual inspection, accumulation of ice or frost on structural members comprising flow channels through the ice condenser is ≤ 0.38 inch thick.~~	18 months

(continued)

INSERT A

Verify, by visual inspection, accumulation of ice on structural members comprising flow channels through the ice bed is ≤ 15 percent blockage of the total flow area for each safety analysis section.

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.6.11.2	Verify total weight of stored ice is ≥ 2,403,800 lb by: a. Weighing a representative sample of ≥ 144 ice baskets and verifying each basket contains ≥ 1236 lb of ice; and b. Calculating total weight of stored ice, at a 95% confidence level, using all ice basket weights determined in SR 3.6.11.2.a.	18 months
SR 3.6.11.3	Verify azimuthal distribution of ice at a 95% confidence level by subdividing weights, as determined by SR 3.6.11.2.a, into the following groups: a. Group 1-bays 1 through 8; b. Group 2-bays 9 through 16; and c. Group 3-bays 17 through 24. The average ice weight of the sample baskets in each group from radial rows 1, 2, 4, 6, 8, and 9 shall be ≥ 1236 lb.	18 months
SR 3.6.11.4	Verify, by visual inspection, accumulation of ice on structural members comprising flow channels through the ice bed is ≤ 15 percent blockage of the total flow area for each safety analysis section.	18 months

(continued)